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RELATED CORRESPONDENCE

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

DOCKETED USNRC

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

'84 AGO 13 A10:59

In the Matter of	)	
	)	
CAROLINA POWER & LIGHT COMPANY and NORTH CAROLINA EASTERN MUNICIPAL POWER AGENCY	)	Docket Nos. 50-400 OL 50-401 OL
	)	
(Shearon Harris Nuclear Power Plant, Unit 1)	)	

TESTIMONY OF JOHN CLEWETT
ON BEHALF OF JOINT INTERVENORS
ON JOINT CONTENTION I.

Q. Please state your name.

A. John Clewett.

Q. What is your educational background?

A. I received a Bachelor of Arts degree in economics from Stanford University in 1972. I received my law degree from the University of California at Los Angeles law school in 1975.

Q. Where have you been employed since your granduation from law school?

A. From 1975 - 1980 I worked for the Federal Trade Commission. During 1981 and 1982 I worked with the Christic Institute. During 1982 and 1983 I worked for the Critical Mass Energy Project. I am currently doing consulting work and some private legal practice.

Q. As part of your responsibilities with the Critical Mass Energy Project, were you in charge of preparing a report?

DS03

A. Yes. I was in charge of preparing a report entitled "Public Citizen 1983 Nuclear Power Safety Report". A copy of that report is attached to this testimony as Exhibit A.

Q. How was that report prepared?

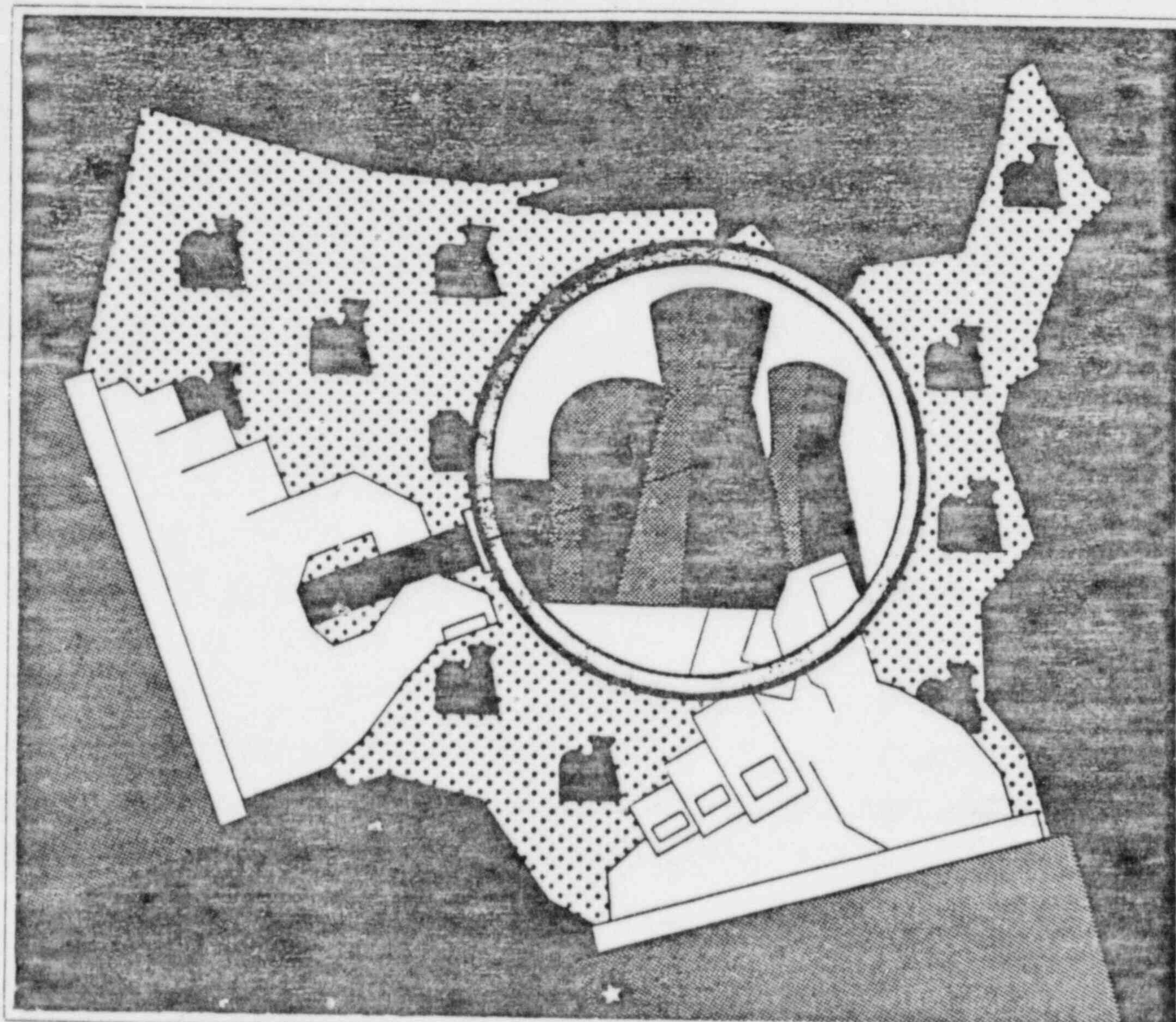
A. We obtained a variety of Nuclear Regulatory Commission documents from the Public Document Room, and also as a result of requests made under the Freedom of Information Act. Those documents covered the operation of all of the nuclear power plants in the United States during 1982 and part of 1983. The report consists of a compilation and summary of the information contained in those documents. The methodology we employed is described at pages 30 and 31.

Q. As a result of that study of NRC documents, did you reach any conclusion concerning the management of the Brunswick Nuclear Power Plant?

A. Yes. As indicated at page 7 of the report, we concluded that, for the period covered by the report, the Brunswick Plant was the worst-managed operating nuclear plant in the United States.

Public Citizen

1983 Nuclear Power Safety Report



By John Clewett
and the Critical Mass Energy Project staff

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EXHIBIT A

Public Citizen 1983 Nuclear Power Safety Report

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Critical Mass Energy Project (CMEP) was founded in 1974 by Ralph Nader at the first Critical Mass Conference, and is a part of Public Citizen. The president of Public Citizen is Joan Claybrook. The director of CMEP is Michael Totten.

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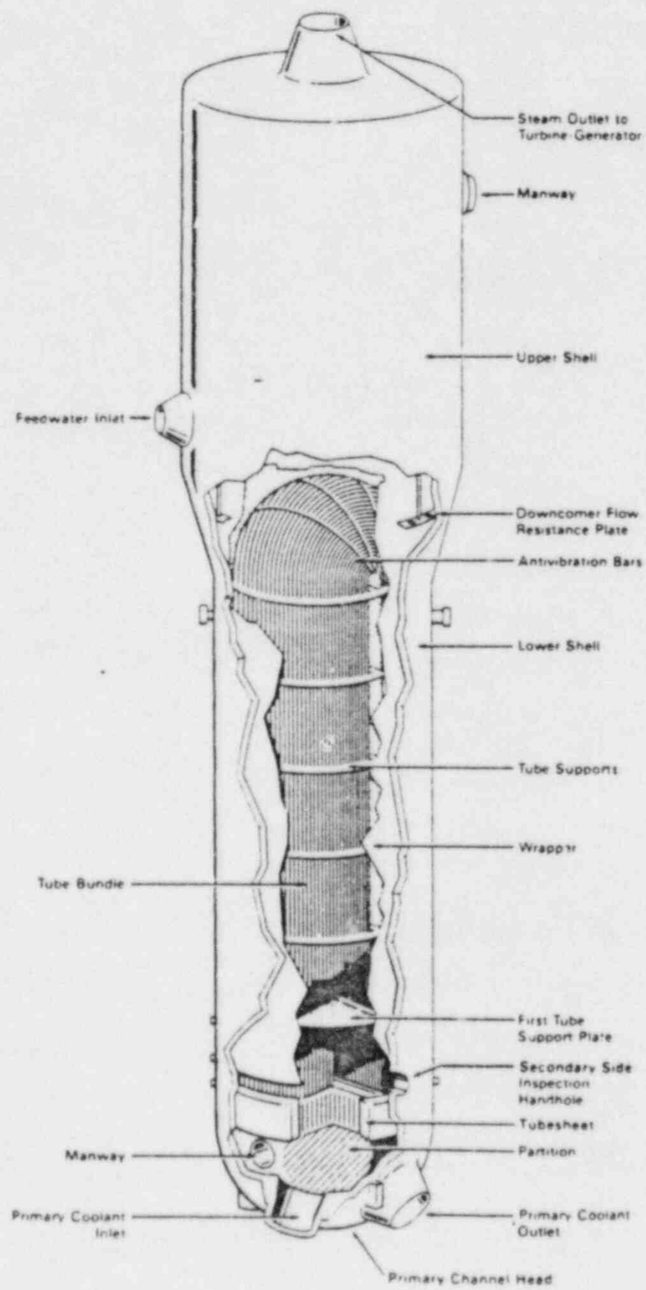
Cover illustration by John Herne



Westinghouse Model 44 steam generator

Fig. 1: The Steam Generator at Ginna

Public Citizen

1983 Nuclear Power Safety Report

Introduction

In 1982 nuclear power plants showed themselves once again to be an unreliable, expensive and potentially very dangerous power source.

For the fourth year in a row, Public Citizen's Critical Mass Energy Project has examined a crucial aspect of nuclear power — the safety of operating plants. Among our findings:

• There were 4,500 mishaps reported at nuclear power plants during the 1982 calendar year, up more than 10% from the 1981 total. Ten plants had more than 100 mishaps each.

• Of the mishaps in 1982, 253 were considered particularly significant, according to NRC reports. Nineteen reactors suffered five or more "particularly significant mishaps,"* with **Brunswick 2** (Southport, NC) and **Salem 2** (Salem, NJ) heading the list with ten each.

• Nearly 50 percent of the mishaps in 1982 were due to equipment problems or failures, and more than 20 percent involved defects in design or fabrication. More than 25 percent involved human error.

• More workers than ever before, 84,322, were exposed to measurable amounts of radiation. The number of exposed workers has increased 113-fold since 1969, considerably higher than the 25-fold increase in nuclear electricity generated over the same period.

• One of every three nuclear plant workers with measurable radiation doses received more than 500 millirems (.5 rems), three times higher than the recommended maximum exposure to the general public (170 millirems, or .17 rems).

• The NRC levied 23 fines to 20 utilities in 1982 for a total of $1,895,125. Boston Edison paid the heaviest fine, $550,000, for making false statements to the NRC, and for their inability to control combustible gases after a possible loss-of-coolant accident at the **Pilgrim** (MA) plant, and Carolina Power and Light was fined $600,000 in 1983 for failure to adequately test the safety systems at the **Brunswick** (NC) plant in 1982.

• There were over 60 security threats to nuclear plants in 1982, and six plants had three or more threats. The **Salem** (NJ) site, operated by Public Service Electric and Gas, had the highest number, with six security threats. Five were sabotage, apparently done by plant "insiders." One incident led to an airborne release of 19 curies of Xenon-133. There were 34 bomb threats, including sixteen in a seven week period at Indiana's **Marble Hill**. A bomb device was set off in the reactor building at the **Bellefonte** plant under construction in Alabama.

• As of July 1983, 24 nuclear plant sites lacked state or county emergency evacuation plans.

The sources we have used in reaching these conclusions are NRC documents, many obtained using the Freedom of Information Act (FOIA). These documents reflect the agency's evaluation of which nuclear mishaps are most important for their safety significance and relevance to other nuclear plants.

Among the mishaps in 1982 that were considered particularly significant by the NRC:

• January 25, **Ginna** (NY): a steam generator tube ruptured causing violent fluctuations in pressure throughout the reactor system and leading to the release of a substantial amount of radioactivity into the atmosphere.

• February 1, **Salem** (NJ): 23,000 gallons of radioactive water spilled onto 16 workers.

• February 4, **Palisades** (MI): A hydrogen explosion in a generator injured a worker and started a fire.

• March 3, **Nine Mile Point** (NY): Severe pipe cracking forced the complete replacement of the reactor coolant recirculation system.

• June 1, **Indian Point** (NY): A worker was exposed to a dose of radiation equivalent to more than 400 chest X-rays.

• June 19, **Peach Bottom 2 & 3** (PA): Because of a design problem in the electrical systems at Unit 2, the emergency systems at Unit 3 were accidentally triggered.

• November 11, **Point Beach** (WI): A 5-foot metal bar and a 6-inch "C" clamp were found inside one of the steam generators. This is symptomatic of the recurring problem of loose parts in the steam generators of pressurized water reactors, which can harm the delicate steam generator tubes. The **Ginna** accident was caused by loose parts inside one of its steam generators.

*The total number of "particularly significant mishaps" cannot be directly compared to the total number of "especially significant mishaps" calculated last year, because of methodological differences. For a description of methodology, see page 30.

These mishaps and many others are discussed further in this report. They clearly show that nuclear power operation threatens the health and safety of the public with a seemingly endless series of mishaps caused by human error, design defects, and equipment failures.

The primary source documents we used to analyze nuclear plant mishaps are Licensee Event Reports (LERs), which utilities are required to submit to the NRC whenever an "event" occurs that is reportable according to the terms of its operating license. Although LERs contain useful information on a great number of mishaps, there are several problems with this reporting system.

For example, not all plants have the same reporting requirements. In particular, newer plants have more stringent reporting requirements than old ones, so they are required to report certain incidents that older plants would not have to report.

Another problem is that the managerial attitude toward reporting events varies from plant to plant. In the words of one NRC staff member, "some utilities report them as facts and others as fiction and others don't even report sometimes." For instance, although **Turkey Point 3** (FL) reported that the laundry room fire doors were inoperable (LER-250-82-016), a diligent search failed to find any Turkey Point LER that reported the serious mishap of April 29, 1982, when a pump problem led to the automatic shutdown of Unit 3, and because of a design problem also forced Unit 4 to shut down, causing the blackout of 700,000 customers.

Nor can any LER be found from **Sequoyah 1** (TN) that reports the fact that on January 19, 1982, a transformer at that plant literally exploded, shaking the control room, starting a fire and making noise that could be heard a mile away.

The new system will eliminate the requirement to report individual component failures.

In spite of these inconsistencies, the number of LERs reported is a useful index of the relative safety of the various nuclear plants. In the past when the NRC has ranked the plants on safety, plants with higher numbers of LERs have generally gotten lower rankings.

In addition to tabulating the total number of mishaps at each plant, we also tabulated the total number of particularly significant mishaps in 1982. This total is taken from NRC sources that focus on mishaps of particular safety significance because of their direct health and safety risks or their safety implications for similar plants to be aware of. Because of methodological differences, the total number of particularly significant mishaps cannot be directly compared to the total number of "especially significant mishaps" for 1981 reported in last year's study. The methodology we followed is explained on page 30.

Tables of the worst plants, in terms of the total number of mishaps and the total number of particularly significant mishaps, appear on page 5.

1983 could well be the last year for which complete information about reactor mishaps is publicly available. This is because the NRC is planning to drastically change its LER reporting system, starting on January 1, 1984. The new system, published as a final rule on July 26, 1983 (48 F.R. 33850), will hold all utilities to a single reporting requirement, which is good, but it will completely eliminate the current requirement to report individual component failures. In theory, these will be reported to the voluntary "Nuclear Plant Reliability Data System" (NPRDS) of the Institute for Nuclear Power Operations (INPO), an industry organization set up in the aftermath of the Three Mile Island accident. The NRC says the new system will save the utilities money they would ordinarily spend on preparing LERs, which are expected to be reduced by at least half under the new rules.

Of an NRC sample of 104 component failures only 21 were reported to NPRDS.

There are several problems with reporting nuclear plant mishaps to the industry itself instead of to the NRC. One is that utility participation in NPRDS has so far been very poor. Of an NRC sample of 104 component failures in the first three months of 1982, only 21 were reported to NPRDS by the end of April. If the pattern remains the same, even highly significant component failures may not be reported, such as the August 20, 1982 failure of a shutdown-system breaker at **Salem 2** (NJ) that foreshadowed the complete failure of the automatic shutdown system at **Salem 1** five months later.

A second problem is that although the Institute for Nuclear Power Operations provides information such as NPRDS to the NRC, it does so under an agreement that prohibits the NRC from releasing it to the public. This amounts, in effect, to a loophole in the Freedom of Information Act. Because of the agreement with INPO, the NRC refused for a second year in a row to give Critical Mass access to INPO's *Significant Event Reports*, which describe plant mishaps, and the NPRDS data will probably be treated the same way, so that the public will be kept in the dark about many of the mishaps at nuclear plants.

A related problem is that plant managers will often be faced with the choice of reporting a mishap to the NRC as an LER, or considering the event as a component failure reportable only to NPRDS. This option will allow them to hide information about major mishaps from the public by characterizing them as primarily component failures.

It is unfortunate that the NRC is retreating from a relatively open system of reporting nuclear mishaps to one that will be largely hidden from the public. It shows how the "mindset" of the NRC, so thoroughly criticized by the Kemeny and Rogovin reports after the Three Mile Island accident, is still more concerned with the welfare of the nuclear industry than the welfare of the public.

Major Mishaps

Among the 4500 reactor mishaps reported by the NRC in 1982, more than 250 were analyzed in some detail by the NRC's safety experts, because of their direct or potential safety significance. All of these "particularly significant mishaps" are listed beginning on page 18, along with references to find further information. Some illustrative examples of the mishaps viewed as particularly significant by the NRC are discussed in greater detail below.

•On January 25, 1982, the **Ginna** (NY) plant suffered the largest steam generator tube rupture in history. The NRC declared this to be an "Abnormal Occurence," meaning that it caused a "major reduction in the degree of protection of the public health and safety." The Ginna accident is discussed in detail elsewhere on this page.

Two of the most potentially dangerous incidents of 1982 were caused not by equipment failure or human error, but by the elemental forces of nature itself.

•One such mishap occurred at the **Dresden** (IL) plant, on December 3, 1982. The Illinois River, swollen by rain, flooded to a level more than two feet higher than had ever been previously recorded. The plant declared an official Alert, and began to shut down the reactors, when the water had reached a level only 4 inc... below the floor of the "crib house" that holds the emergency fire pumps and the service water pumps. The fear was that the water would disable the electrical circuitry and motors of this vital equipment, which is needed for fire protection and to cool the reactor when it is shut down. Because of the "decay heat" produced by the reactor fuel, it is necessary to cool the reactor even after the atomic reaction has been shut down. If this function were impaired for a prolonged time, the water in the reactor core could all boil away, causing the fuel to melt.

A design change by Westinghouse made the valves look open when in fact they were closed.

The water crested at 5½ inches above the floor of the crib house, but fortunately no damage was done to vital electrical equipment.

•Another flood occurred that same day at the **Arkansas** (AR) plant, where 12 inches of rain fell in 24 hours. Water entered the turbine building and auxiliary building sumps, and knocked out all telephone communication with the outside world. Lightning had struck the meteorological/radio tower the day before and disabled it. The only form of communication available was by microwave relay system. Had the water continued to rise, it could have disabled vital equipment in the auxiliary building, such as the emergency core cooling system pumps. And if the plant had been seriously disabled, emergency communications from the site could have been practically impossible.

One of the most threatening types of accidents, and one that the NRC has recognized as an Unresolved Safety Issue, is "Station Blackout," a loss of the electrical power needed by the plant to function. Several mishaps during 1982 showed how great the risk of this type of accident is.

•At the **Quad Cities** (IL) plant, Unit 1 lost all of the emergency diesel generators which act as backup if offsite power is lost, and Unit 2 lost all but one emergency diesel generator and all offsite power. If it were not for the one remaining diesel generator, Unit 2 would have lost all AC power.

The incident started at 5:25 a.m. on June 22, 1982,

Ginna

The worst single nuclear power plant accident during 1982 occurred on January 25 at the Robert E. Ginna nuclear plant near Rochester, New York. At 9:25 in the morning, with the plant running at 100 percent power, a steam-generator tube ruptured, spilling 760 gallons a minute of highly radioactive water from the "primary" coolant (the pressurized water that cools the reactor core) into the "secondary" coolant (which turns into steam that spins a turbine connected to an electrical generator). Steam generators are one of the most troublesome parts of nuclear power plants, as discussed in Public Citizen's recently released book, *Tube Leaks: A Consumer's and Worker's Guide to Steam Generator Problems at Nuclear Power Plants.*

The leak, at such a high rate, created two problems for the operators of the plant — too much water in the steam generator, and not enough in the primary coolant. Within the first few minutes of the accident, the pressure in the primary cooling system dropped from 2200 pounds per square inch (psi) to 1200 psi, and because of the reduced pressure, steam began to form in the reactor vessel.

At 9:28, the automatic safety systems "tripped" the reactor, and initiated the emergency "high pressure coolant injection" (HPCI) pumps, which pumped a large quantity of water into the reactor vessel, and drove the pressure back up, to 1350 psi. For the time being, this collapsed the steam bubble in the reactor. Leaking into the steam generator continued, at about 400 gallons per minute.

During the first fifteen minutes of the accident, the plant operators didn't know which steam generator was leaking, but at 9:40, with the use of a hand-held radiation monitor, it was confirmed that the "B" steam generator was the source of the problem.

Knowing this, the operators isolated the steam generator by closing its main steam isolation valve (MSIV). But this didn't stop the flow of water through the ruptured pipe. The water flow posed a problem because if the pressure in the steam generator became too great, it would force open a relief valve and release radioactive steam to the atmosphere.

continued on p. 6

when an operator accidentally pulled the wrong fuses, disconnecting power to various plant systems, including one of the reactor cooling pumps, and leading to a reactor shutdown. Shortly thereafter, the Unit 2 main transformer failed, leaving Unit 2 without any offsite power at all. Two emergency diesel generators started up to supply power. One of these is available only to Unit 2 and one is shared by Units 1 and 2. Shortly after starting, however, the shared diesel generator failed, leaving Unit 2 completely reliant on the one remaining diesel generator to supply electricity for the vital functions of the plant.

The failure of the shared diesel generator also left Unit 1 without any diesel generator power because the other diesel that serves Unit 1 was out of service for maintenance. Had offsite power to Unit 1 failed, as it had to Unit 2, the plant would have had no electricity at all, leaving the plant without the use of any vital motor-driven pumps, such as the emergency core cooling system pumps, or the auxiliary feedwater pumps.

Because of the seriousness of this mishap, the NRC declared it to be an Abnormal Occurence in its quarterly report to Congress.

Other plants where the diesel generators failed in 1982, and where offsite power was also lost, are listed on page 27.

The NRC also declared the following mishap to be an "Abnormal Occurrence":

•At the **Farley** (AL) plant, on October 24, 1982, the operators discovered that the containment spray system was inoperable because certain isolation valves were locked shut. The containment spray system is a crucial safety system used to condense steam released from the reactor cooling system. If the reactor has a loss of coolant accident, a great deal of steam would need to be condensed in order to keep the pressure in the containment building within the limit it was designed to withstand, so that radioactive steam would not be released to the atmosphere.

An investigation revealed that the containment spray system had never been workable since before the plant was first started up, on May 8, 1981. The problem was due to operator error and to a design change by Westinghouse, the manufacturer of the reactor, which made the valves look like they were open when in fact they were closed.

One of the most important safety systems at a nuclear plant is the system that automatically shuts down or "scrams" the reactor when an accident starts to happen. Because of the importance of this function, nuclear plants have two separate systems to automatically scram the reactor. These systems received a great deal of attention in early 1983 when the Salem 1 reactor experienced an "Anticipated Transient Without Scram" (ATWS) in which both of its automatic shutdown circuit breakers failed, and the plant operators failed to notice it until both failed again three days later.

Although Salem was the first time that both systems have failed simulataneously, one of the two automatic shutdown systems failed at a number of plants in 1982.

• The most ironic of these mishaps occurred at **Salem 2** (NJ), the twin of the plant wher the entire automatic shutdown system would fail in 1983. On August 20, one of the two circuit breakers in that system failed because of mechanical binding in the undervoltage trip mechanism, the same part of the breaker that caused the ATWS accidents in 1983. In response, the plant management simply replaced the breaker and started the plant back up.

The following tables list other plants that had automatic shutdown-system breaker failures in 1982 and prior to 1982.

Plants with Automatic Shutdown System Problems in 1982

Plant	Number of Problems	Plant	Number of Problems
Arkansas 1	5	Rancho Seco	1
Arkansas 2	1	Robinson 2	2
Calvert Cliffs	3	Salem	1
North Anna	1		

Plants with Automatic Shutdown System Problems Prior to 1982

Plant	Number of Problems	Plant	Number of Problems
Arkansas 1	3	Oconee 3	4
Arkansas 2	2	Point Beach 1	1
Calvert Cliffs	3	Point Beach 2	2
Crystal River 3	1	Robinson 2	3
Davis-Besse	2	St. Lucie	1
Haddem Neck	1	Surry 2	1
Kewaunee	3	Three Mile Island 1	4
North Anna	1	Zion 1	2
Oconee 1	2	Zion 2	3

Source: Generic Implications of ATWS Events at the Salem Nuclear Power Plant, NUREG-1000 (1983).

The President's Commission on Three Mile Island (the Kemeny Commission), in reviewing the TMI accident and the nuclear industry as a whole, wrote in its report that "the fundamental problems are people-related problems." That observation is still true, as can be seen by the role human error played in a number of 1982 mishaps. For example:

• On November 9, 1982, at **San Onofre** (CA), a technician knocked a power cord out of its socket, causing a sharp drop in feedwater flow to one steam generator and decreased water levels in both steam generators. The operators then shut down the reactor as a precaution. Meanwhile, the technician plugged the cord back in, causing too much water to flow to the steam generators, which caused excessively rapid cooling of the reactor, and partial depressurization of the reactor coolant system. In a pressurized water reactor an "overcooling transient" can lead to a Pressurized Thermal Shock accident, where high pressure and low temperature could crack the reactor vessel and cause a loss-of-coolant accident, of a type the plant is not designed to handle. Conversely, if the primary coolant is not kept at high enough pressure, steam can form in the reactor vessel, preventing the adequate cooling of the reactor core.

This is only a very brief list of some of the major mishaps of 1982. For a complete listing of the "particularly significant mishaps" of 1982, see page 18.

The Worst

More than 100 Mishaps In 1982

Plant	Number
Grand Gulf	185
San Onofre 2	170
Salem 2	157
Brunswick 1	150
Brunswick 2	141
Hatch 2	139
LaSalle 1	132
Surry 1	121
Cook 2	116
Cook 1	113

5 or More Particularly Significant Mishaps in 1982

Plant	Number
Brunswick 2	10
Salem 2	10
McGuire 1	8
North Anna 1	8
Hatch 2	7
Oconee 3	7
Pilgrim 1	7
Trojan	7
Brunswick 1	6
Palisades	6
Salem 1	6
Arkansas 1	5
Farley 2	5
LaSalle 1	5
Millstone 1	5
Rancho Seco	5
San Onofre 1	5
San Onofre 2	5
Zion 2	5

For more information on mishaps, see pp. 16-21; on worst case accidents, pp. 22-24, on capacity factors, pp. 16-17, on worker exposure to radiation, pp. 10-11; on plant management ratings, pp. 7-10.

Worst 1982 Capacity Factors

Plant	Capacity Factor
Three Mile Island 1	00.0
San Onofre 1	13.4
Indian Point 3	17.0
Ft. St. Vrain	19.7
Nine Mile Point	20.9
Brunswick 2	26.2
Oconee 3	27.2
North Anna 1	30.2
La Crosse	31.5
Oyster Creek	35.4
Beaver Valley 1	36.0

Worst Lifetime Capacity Factors

Plant	Capacity Factor
Ft. St. Vrain	20.9
Beaver Valley 1	35.8
Palisades	38.3
McGuire 1	38.5
Three Mile Island 1	39.9
Davis-Besse	40.2
Brunswick 2	40.9
La Crosse	45.5
Salem 1	46.8
Indian Point 3	47.0
Brunswick 1	48.5
Rancho Seco	49.2
Sequoyah 1	49.2

Most Workers Exposed to Measurable Doses of Radiation

Plant	Workers
Brunswick 1/2	4957
Hatch 1/2	3418
Browns Ferry 1/2/3	3277
Salem 1/2	3228
San Onofre	3055
Turkey Point 3/4	2956
North Anna 1/2	2872
Pilgrim 1	2854
Peach Bottom	2734
Dresden 1/2/3	2572

Highest Percentage of Exposed Workers Who Were Exposed to 0.5 Rems or More

Plant	Percentage
Quad Cities 1/2	73.42
Zion	65.33
La Crosse	58.11
Dresden 1/2/3	55.68
Ginna	54.43
Point Beach 1/2	48.50
Nine Mile Point	48.45
Indian Point 3	47.05
Cooper Station	46.30
Indian Point 1/2	46.08

Greatest Number of Deaths in a Worst Case Accident

Plant	Deaths
Salem 1	140,000
Peach Bottom	109,000
Limerick	108,000
Waterford	105,000
Susquehanna	95,000
Three Mile Island	74,000
Indian Point	64,000
Millstone	61,000
Dresden	55,000
San Onofre	55,000
Surry	54,000
Haddam Neck	52,000

Highest Costs in a Worst Case Accident

Plant	Cost (Billions $)
Indian Point	314
Limerick	213
San Onofre	186
Millstone	174
Seabrook	163
Diablo Canyon	158
Shoreham	157
Salem	150
Zion	146
Susquehanna	143
Fermi	135
Nine Mile Point	134
Waterford	131
Braidwood	127
Beaver Valley	122
Three Mile Island	122
LaSalle	120
Peach Bottom	119
Comanche Peak	117
Byron	114
Rancho Seco	113
South Texas	112
Callaway	110
McGuire	110

The Worst-Managed Plants

Operating	Under Construction
1.Brunswick 1/2	1.Waterford 3
2.Arkansas 1/2	2.Watts Bar 1/2
3.Browns Ferry 1/2/3	3.Byron 1/2
4.Duane Arnold	4.Midland
5.San Onofre 1	5.Clinton
6.Grand Gulf	6.WPPSS 3/5

continued from p. 3

To slow down the leak rate, there is a "power-operated relief valve" (PORV) that can ordinarily be opened to release some of the pressure on the primary side. But this valve was not functional, because automatic shutdown systems had disabled the instrument air system necessary to control the PORV. In the words of Robert Pollard, a nuclear safety engineer at the Union of Concerned Scientists (UCS), "It's guaranteed not to work when needed." UCS had pointed out this failure to the NRC after the Three Mile Island accident, in which the same valve played a key role, but no change was made at Ginna.

Meanwhile, radioactive water continued to pour through the hole, completely filling the "B" steam generator. Later, the attached main steam line also flooded.

By 10:07, the instrument air system had been restored, and the operators were able to open the PORV to release some of the pressure. It successfully cycled open and closed three times, but then stuck open (just as the PORV had done during the Three Mile Island accident). Pressure in the reactor core dropped, from 1350 psi to 850 psi, causing steam to form in the core once again. The NRC estimated that the size of this steam bubble reached 300 cubic feet in size.

The accident was caused by a foreign object in the steam generator.

The danger posed by a steam bubble in the reactor core of a pressurized water reactor is that it can prevent water from adequately cooling the core, which could lead to a melting of the fuel, the most serious of reactor accidents. To avert this, the reactor operators closed the "block valve" leading to the PORV, so that pressure could build back up.

Another way to relieve some of the excess primary system pressure would have been to turn off the high-pressure injection pumps that were pumping large amounts of extra water into the reactor core. After the block valve was closed, at 10:11, the pressure in the core increased enough that operators could have turned off the safety injection system. And the water level indicator in the "pressurizer" was high, usually a good indication that there is enough water in the core.

But the operators hesitated to turn off the safety injection, because they knew there was a steam bubble in the core. During the TMI accident, such a bubble drove water into the pressurizer, leading the operators to think there was too much water in the system, when in fact the core was uncovered, overheating and becoming damaged. After the TMI accident, the NRC had recommended the installation of a reactor vessel water level indicator, but Ginna hadn't installed one yet..

So they left the safety injection system on, and the leaking into the steam generator continued, until its pressure reached 1080 psi at 10:19, forcing open a steam generator relief valve that released radioactive steam to the atmosphere, until the pressure fell by about 50 psi. When the pressure built up again, it opened again, releasing more radioactive steam, at 10:28, and again at 10:38. After the third release, the operators finally cut off the high pressure injection. They later turned it on again as a precaution against loss of too much reactor coolant pressure after a reactor coolant pump was restarted, and the steam generator relief valve opened twice more, at 11:19 and 11:37. After the last opening, it failed to fully close, and leaked radioactive water until about 12:25 pm.

Shortly after the steam generator's leaking safety valve reseated at 12:25 pm, the pressure between the reactor coolant system and the steam generator reached equilibrium, and the leak through the ruptured pipe stopped.

Slowly the plant crawled toward a safe shutdown. The pressure in the reactor coolant system was maintained at 25 psi less than that of the steam generator so that the radioactive water could slowly be drained through the ruptured tube into the reactor coolant system. By 6:40 pm the steam generator water level indicator came back on scale. Finally, at 6:53 the following evening, January 26, 1982, the licensee declared the plant to be in a cold shutdown condition. It would not operate again for four months, until May 25.

Although it was impossible to tell exactly how much radiation was released from Ginna, the NRC estimates that 90 curies of "noble gases" such as krypton were released, along with 25 curies of tritium, 5 curies of iodine, and 1.3 curies of cobalt, molybdenum, barium and cesium. (A curie is a unit of radioactivity equal to 37 billion radioactive disintegrations per second.) During the first three hours of the accident, when most of the radioactivity was released, the wind was blowing toward the southeast. Because of snow and moist cold air, most of the radioactivity fell to earth fairly close to the plant.

The cause of the Ginna accident was probably a foreign object that found its way into the steam generator, starting a sequence of events that led to the tube rupture. During various modifications to the steam generators, beginning in 1975, quality control was inadequate, and objects that fell into the steam generators were not detected. These objects damaged the outermost tubes, some of which were eventually plugged to avoid leakage or rupture. Eventually, however, some of the plugged tubes were damaged so badly that they collapsed and in some cases severed altogether. These tubes damaged tubes nearby, which were, in turn, plugged. Some of these also severed, until eventually the fated tube "R42C55" (so-called because it is in Row 42, Column 55 of the steam generator) became damaged. The wear on tube R42C55 occurred in a gradual enough manner that it did not show any small-scale leakage before rupturing completely.

Although Ginna was the most drastic, at least 17 other nuclear plants had smaller tube leaks during 1982. Nor is the problem of foreign objects in the steam generators unique to Ginna. In 1982 alone, 7 plants discovered loose objects in their steam generators, including Cook 1 (MI), McGuire 1 (NC), North Anna 1 (VA), Point Beach 1 and 2 (WI), San Onofre 1 (CA), Turkey Point 4 (FL) and Zion 1 (IL). This debris can damage the delicate steam generator tubes, causing leaks or a dramatic tube rupture like the one at Ginna.

For a discussion of generic problems with generator problems, see page 25. For an in-depth look at steam generator problems, see Public Citizen's book *Tube Leaks: A Consumer's and Worker's Guide to Steam Generator Problems at Nuclear Power Plants*, available from Critical Mass.

Plant Management Ratings

One measure of the safety of nuclear plants is how well they are managed. A well managed plant is less likely to have a serious accident, and staff and machines are more likely to respond properly after an accident begins than a poorly managed one.

For several years, the NRC has regularly evaluated the management of nuclear plants. This "Systematic Assessment of Licensee Performance" (**SALP**) program is intended to help the NRC understand how each plant's management "directs, guides, and provides resources for assuring plant safety."

Until recently, the NRC gave overall management ratings of 1, 2 or 3, with a rating of 1 being above average, and 3 being below average. The NRC published the results in NUREG-0834. (These ratings are listed in *Public Citizen's Nuclear Power Safety Report: 1981*, on p. 7.)

Because of the adverse publicity that publication of this data brought on the owners of the below-average plants, the NRC revised its procedure in 1982 so that overall ratings are no longer officially made, and so that the ratings are reviewed by the NRC regional offices rather than by NRC headquarters in Washington, D.C.

Although the official ratings are now based on various functional areas such as maintenance, radiological controls and the like, rather than on the state of the whole plant, Critical Mass has discovered that the NRC staff still calculates an overall average rating for its own use. In a notebook obtained through the Freedom of Information Act from the NRC's Office of Inspection and Enforcement, there is a tabulation of the SALP results for each plant by category, and in a column that has been erased, numbers can still faintly be seen that correspond to averages of the ratings for the various areas covered by the report. The NRC staff has confirmed that these numbers have been erased, but stated that the erasure occurred before our Freedom of Information Act request was made. (If it took place after the request was made, it would violate federal law.)

These average ratings are potentially very useful to the NRC and the public, because poor overall ratings tend to show across-the-board management problems and point to the plants that need closer attention from the NRC in order to be run more safely.

The connection between poor management and unsafe plant operation was brought into stark contrast recently because of the February 22 and 25, 1983, "Anticipated Transient Without Scram" (ATWS) accident at the Salem-1 plant in New Jersey. The Commission was horrified to learn that the plant's managers didn't even realize that there had been a failure of the automatic reactor-shutdown systems until it happened again three days later. A later investigation showed that the failed shutdown equipment had not been classified as safety-related, had not been oiled in 7 years, and was subsequently lubricated with the wrong oil.

Because of this shock, the NRC has been reevaluating its SALP program and may decide to go back to a numerical grading system of overall performance based on a weighted average of the ratings for each individual area, and may reevaluate poorly-managed plants more often than well-managed ones.

In the meantime, however, it is still possible to derive useful information about overall management at particular nuclear plants by averaging the ratings given for the various areas rated. Critical Mass has done this, based upon the most recent SALP report for each operating plant and each plant under construction, with the results for each functional area, and the overall average, shown in the tables on the next two pages. (Some plants were evaluated along with operating plants even though they were only in pre-operational stages.)

The NRC explains the various ratings as follows:

1. "Reduced NRC attention may be appropriate. Licensee management attention and involvement are aggressive and oriented toward nuclear safety; licensee resources are ample and effectively used such that a high level of performance with respect to operational safety or construction is being achieved."

2. "NRC attention should be maintained at normal levels. Licensee management attention and involvement are evident and are adequate and are reasonably effective such that satisfactory performance with respect to operational safety or construction is being achieved."

3. "Both NRC and licensee attention should be increased. Licensee management attention or involvement is acceptable and considers nuclear safety, but weaknesses are evident; licensee resources appear to be strained or not effectively used such that minimally satisfactory performance with respect to operational safety or construction is being achieved."

The worst-managed plants, overall, are shown in the tables below.

THE WORST-MANAGED OPERATING NUCLEAR PLANTS

Plant	Location	Average SALP Rating
1. Brunswick 1/2	NC	2.57
2. Arkansas 1/2	AR	2.45
3. Browns Ferry 1/2/3	AL	2.43
4. Duane Arnold	IA	2.38
5. San Onofre 1	CA	2.36
6. Grand Gulf	MS	2.33

THE WORST-MANAGED PLANTS UNDER CONSTRUCTION

Plant	Location	Average SALP Rating
1. Waterford 3*	LA	2.50
2. Watts Bar 1/2	TN	2.40
3. Byron 1/2	IL	2.30
4. Midland	MI	2.29
5. Clinton	IL	2.25
6. WPPSS 3/5	WA	2.25

*The very worst plant under construction is almost certainly the Zimmer plant. Because of widespread quality-assurance problems at that plant, the NRC has ordered construction halted pending an investigation.

In addition to comparing the results of various plants, it is revealing to consider the average rating given by each of the NRC regions, because there is a considerable variation in how tough the regions are on the plants they inspect. In

Management Ratings: Operating Nuclear Plants*

KEY: See page 9.

Plant Name	State	NRC Region	SALP Date	A	B	C	D	E	F	G	H	I	J	K	ETC	Average Rating
Arkansas 1/2	AR	IV	08/82	3	2	3	3	2	3	2	2	2	2	—	3	2.45
Beaver Valley 1	PA	I	03/82	2	1	3	2	2	2	3	2	2	—	—	—	2.11
Big Rock Point	MI	III	09/82	1	3	1	2	2	2	2	1	2	3	—	2	1.91
Brunswick 1/2	NC	II	05/82	3	3	3	2	3	2	2	N	N	—	—	—	2.57
Brown's Ferry	AL	II	10/82	3	3	2	2	3	N	2	2	N	—	—	—	2.43
Calvert Cliffs 1/2	MD	I	11/82	2	1	2	1	1	1	2	1	2	—	—	3	1.60
Cook 1/2	MI	III	05/83	2	2	2	2	3	2	2	2	2	—	2	—	2.20
Cooper	NB	IV	08/82	1	2	1	1	1	3	1	1	1	2	—	2	1.45
Crystal River 3	FL	II	10/82	2	2	3	1	2	2	2	2	3	—	—	—	2.11
Davis-Besse	OH	III	06/82	2	1	3	2	2	1	2	1	2	—	3	2	1.91
Dresden 1/2/3	IL	III	04/82	3	3	2	2	3	1	1	1	1	—	—	3,2	2.00
Duane Arnold	IA	III	10/82	2	3	2	2	2	3	2	3	N	—	—	—	2.38
Farley 1/2	AL	II	12/82	1	1	1	1	2	1	1	1	2	—	—	—	1.22
Fitzpatrick	NY	I	05/82	3	3	2	2	2	2	1	2	2	—	—	—	2.11
Fort Calhoun	NB	IV	10/82	1	2	2	1	2	2	2	2	1	—	3	2,2	1.83
Fort St. Vrain	CO	IV	11/82	3	2	1	2	1	2	2	N	1	—	—	—	1.75
Ginna	NY	I	09/82	1	2	1	2	2	1	1	1	1	—	—	—	1.33
Grand Gulf	MS	II	01/82	3	2	N	3	N	2	2	N	2	—	—	—	2.33
Haddam Neck	CT	I	10/82	1	1	1	1	1	1	1	1	1	—	—	—	1.00
Hatch 1/2	GA	II	09/81	2	2	2	2	2	N	1	2	N	—	—	—	1.86
Indian Point 2	NY	I	05/82	2	2	2	3	2	2	1	2	2	—	—	—	2.00
Indian Point 3	NY	I	05/82	2	1	1	1	1	2	2	N	2	—	—	—	1.50
Kewaunee	WI	III	05/83	2	2	2	2	1	2	2	1	2	—	—	—	1.78
La Crosse	WI	III	09/82	3	2	1	2	2	3	2	2	2	—	—	2	2.10
LaSalle 1/2	IL	III	05/83	2	2	1	3	2	2	3	1	2	—	—	3,2,2,2	2.08
Maine Yankee	ME	I	09/82	3	2	2	2	1	2	2	N	2	—	3	—	2.00
McGuire 1	NC	II	09/82	2	1	1	1	2	1	2	1	2	—	—	—	1.44
Millstone 1	CT	I	10/82	1	1	1	1	1	1	2	1	1	—	—	—	1.11
Millstone 2	CT	I	10/82	1	1	1	1	1	1	2	2	1	—	—	—	1.22
Monticello	MN	III	09/82	1	2	2	1	2	1	1	1	1	—	—	2	1.40
Nine Mile Point 1	NY	I	06/82	2	3	2	2	2	2	1	1	1	—	—	—	1.78
North Anna 1/2	VA	II	01/83	2	1	2	2	2	2	1	1	2	—	2	—	1.70
Oconee 1/2/3	SC	II	09/82	2	2	1	2	2	1	1	1	2	—	—	—	1.56
Oyster Creek 1	NJ	I	04/82	2	2	2	2	2	2	1	2	2	—	—	—	1.89
Palisades	MI	III	09/82	2	3	2	1	2	2	2	2	2	2	2	—	2.00
Peach Bottom	PA	I	07/82	2	3	2	2	3	2	2	2	1	—	—	—	2.11
Pilgrim	MA	I	08/82	3	2	2	2	3	1	2	2	2	—	—	—	2.11
Point Beach 1/2	WI	III	05/83	1	2	1	1	3	3	2	2	2	—	—	—	1.89
Prairie Island 1/2	MN	III	09/82	1	1	1	1	1	2	1	1	1	2	2	2,2	1.38
Quad Cities 1/2	IL	III	03/82	1	2	2	2	2	2	2	1	1	—	—	2	1.70
Rancho Seco 1/2	CA	V	11/82	2	2	2	2	2	2	1	1	1	—	—	3	1.80
Robinson 2	SC	II	05/82	2	3	2	2	2	2	2	2	N	—	—	—	2.13
Salem 1/2	NJ	I	11/82	2	1	1	1	2	2	3	1	2	—	—	—	1.67
San Onofre 1	CA	V	08/82	3	3	3	2	2	1	3	N	2	—	2	2,3	2.36
San Onofre 2/3	CA	V	08/82	2	2	2	2	2	1	2	1	2	—	2	1	1.73
Sequoyah 1	TN	II	10/81	3	2	2	2	2	2	2	N	N	—	—	—	2.14
Sequoyah 2	TN	II	10/81	2	N	N	2	2	2	2	2	N	—	—	—	2.00
Shoreham	NY	I	04/82	N	2	2	N	2	N	2	2	2	—	—	—	2.00
St. Lucie 1	FL	II	10/82	1	1	2	1	2	2	2	1	2	—	—	—	1.56
Summer	SC	II	07/82	2	N	2	2	N	1	2	2	N	2	—	2,2	1.89
Surry 1/2	VA	II	01/83	1	2	2	1	2	2	1	2	2	—	2	—	1.70
Susquehanna 1/2	PA	I	06/82	2	N	2	N	N	2	1	N	2	—	2	2	1.86
TMI 1	PA	I	11/82	1	2	2	1	1	1	1	N	1	—	1	2	1.30
Trojan	OR	V	10/82	2	1	1	2	2	1	1	1	1	—	—	1,2	1.36
Turkey Point 3/4	FL	II	10/82	2	1	2	2	2	2	2	1	2	—	—	—	1.78
Waterford 3	LA	IV	10/82	2	N	N	3	2	N	1	N	N	—	—	†	2.15
Watts Bar 1	TN	II	10/81	N	N	N	2	2	N	2	3	N	—	—	—	2.25
WPPSS 2	WA	V	09/82	2	2	N	N	N	N	N	N	1	—	2	2,2,2	1.86
Vermont Yankee	VT	I	08/82	1	1	1	1	1	2	1	1	1	—	—	—	1.11
Yankee Rowe	MA	I	08/82	1	1	1	1	1	1	1	1	1	—	—	—	1.00
Zimmer 1	OH	III	06/82	N	2	N	N	N	2	2	N	2	—	—	—	2.00
Zion 1/2	IL	III	04/82	2	3	2	2	N	2	2	1	2	—	—	3,2	2.10

Management Ratings: Nuclear Plants Under Construction

Plant Name	State	NRC Region	SALP Date	R	S	T	U	V	W	X	Y	Z	ETC	Average Rating
Beaver Valley 2	PA	I	03/82	1	2	2	N	N	2	N	N	—	1	1.60
Bellefonte 1/2	AL	II	10/81	N	1	2	2	N	2	2	N	—	—	1.80
Braidwood 1/2	IL	III	04/82	N	2	2	2	2	2	2	2	—	—	2.00
Byron 1/2	IL	III	05/83	N	2	2	2	3	3	N	1	3	2,3,2	2.30
Callaway 1/2	MO	III	02/82	2	2	2	2	N	3	N	1	—	—	2.00
Catawba 1/2	SC	II	09/82	N	1	2	2	N	2	N	2	—	—	1.80
Clinton 1/2	IL	III	04/82	2	2	3	2	2	N	2	2	3	—	2.25
Comanche Peak 1/2	TX	IV	10/80	N	N	2	2	N	2	2	N	—	—	2.00
Diablo Canyon	CA	V	05/81	2	2	2	2	2	2	2	N	—	—	2.00
Fermi 2	MI	III	08/80	2	2	3	2	N	2	2	N	—	—	2.17
Grand Gulf 1/2	MS	II	01/83	N	N	2	N	2	2	2	2	2	—	2.00
Hope Creek 1/2	NJ	I	11/82	1	2	1	2	2	N	N	N	—	—	1.60
LaSalle 1/2	IL	III	04/82	N	2	2	2	N	2	2	2	—	2	2.00
Limerick 1/2	PA	I	08/81	N	2	1	2	N	2	2	N	—	—	1.80
Marble Hill 1/2	IN	III	11/82	2	1	2	1	2	2	N	1	1	2	1.56
McGuire 2	NC	II	09/82	N	N	1	N	2	1	1	2	—	1	1.33
Midland 1/2	MI	III	10/81	3	2	3	2	1	3	N	2	—	—	2.29
Millstone 3	CT	I	10/82	1	1	1	2	1	1	1	1	—	2	1.22
Nine Mile Point 2	NY	I	04/81	2	2	2	2	N	2	2	N	—	—	2.00
Palo Verde 1/2/3	AZ	V	05/83	1	1	2	1	2	2	2	1	—	—	1.50
Perry 1/2	OH	III	01/83	N	1	2	2	2	N	N	1	—	2,2	1.71
River Bend 1/2	LA	IV	10/82	N	2	2	2	N	2	N	2	—	2,2	2.00
San Onofre 2/3	CA	V	08/82	N	1	2	2	2	1	2	2	1	1,1	1.50
Seabrook 1/2	NH	I	09/82	1	2	3	2	1	2	1	2	—	2	1.78
Sequoyah 2	TN	II	10/81	N	2	1	2	N	2	N	N	—	—	1.75
Shearon Harris 1/2	NC	II	05/82	2	2	2	2	N	2	N	N	—	—	2.00
Shoreham	NY	I	04/82	N	N	1	N	N	2	2	N	—	—	1.67
St. Lucie 2	FL	II	10/82	N	2	2	1	3	1	1	2	—	1	1.63
Summer	SC	II	07/82	N	1	2	N	N	1	1	N	1	2,2,2	1.50
Susquehanna 1/2	PA	I	06/82	N	N	N	N	N	2	2	2	—	—	2.00
Vogtle 1/2	GA	II	09/81	2	2	2	2	N	N	N	N	—	—	2.00
Waterford 3	LA	IV	10/82	N	2	3	3	N	2	3	2	—	—	2.50
Watts Bar 1/2	TN	II	10/81	N	2	3	3	N	2	2	N	—	—	2.40
WPPSS 1	WA	V	09/82	N	3	2	2	3	2	N	1	—	—	2.17
WPPSS 2	WA	V	09/82	2	2	2	2	N	3	2	1	—	—	2.00
WPPSS 3/5	WA	V	11/82	2	3	2	2	2	2	N	2	—	3	2.25
Wolf Creek	KS	IV	09/82	N	1	2	2	2	2	2	1	1	1	1.67

KEY:

A — Plant operations
B — Radiological controls, including radiation protection, radioactive waste management, transportation and effluent control and monitoring
C — Maintenance
D — Surveillance, including in-service and pre-operational testing
E — Fire protection
F — Emergency preparedness
G — Security and safeguards
H — Refueling, including initial fuel loading
I — Licensing activities
J — Training
K — Quality assurance

R — Soils and foundation
S — Containment and other safety-related structures
T — Piping systems and supports, including welding and pre-service inspection.
U — Safety-related components, including reactor vessel and internals and pumps
V — Support systems, including heating, ventilating and air conditioning, radwaste and fire protection systems
W — Electrical power supply and distribution
X — Instrumentation and control systems
Y — Licensing activities
Z — Quality assurance
Etc — Other categories not listed above
N — Not evaluated

* Some plants were evaluated on the operating-plant categories even though they are only in pre-operational stages.
† The Waterford 3 plant was rated on 9 areas in addition to those listed, with ratings 1, 2, 3, 2, 1, 2, 3, 3 and 3.

Source: "SALP FILE," NRC Office of Inspection and Enforcement.

fact, one of the problems faced by the NRC in reinstituting an overall rating is that the administrators of the five regions haven't been able to agree on how to do it, according to the NRC's Director of Inspection and Enforcement Richard DeYoung.

The following table shows the average SALP ratings by region.

AVERAGE SALP RATING GIVEN BY EACH NRC REGIONAL OFFICE

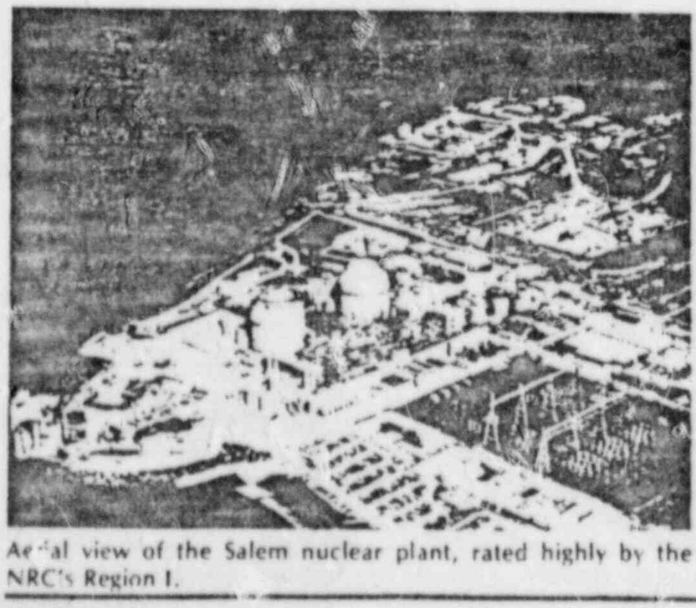
NRC Region		Operating Plants	Under Construction	No. of Rated Plants In Region
I	(King of Prussia, PA)	1.64	1.71	28
II	(Atlanta, GA)	1.92	1.82	27
III	(Glen Ellyn, IL)	1.92	2.03	24
IV	(Arlington, TX)	1.93	2.04	9
V	(Walnut Creek, CA)	1.82	1.90	11

From this chart it can easily be seen that the region which gave the best ratings is the NRC's Region I, which covers Pennsylvania, Delaware, Maryland, the District of Columbia, New York, New Jersey and the New England states. Is Region I going easy on utility managers in its area? It might be supposed that the plants in that region are simply better managed, but that does not seem to be an adequate explanation for the strikingly different ratings from Region I. The NRC's Region I gave good grades to such plants as:

•Salem, the management of which was scrutinized by the Commission itself after the failure of the automatic shutdown systems and soundly criticized for its lack of "intellectual curiosity" about how its plant operates; and

•Three Mile Island 1, which has been shut down since the accident at TMI-2 and which has been among the slowest of all plants to install new safety systems required after the TMI-2 accident. TMI-1 has had a series of cheating incidents on operator license tests, and even the top management of the plant has been implicated in making materially false statements to the NRC. Commissioner Victor Gilinsky has called for the resignation of the top management of TMI's owners before allowing Unit 1 to restart.

Results like these underline the need for close supervision of the SALP process by the Commission itself to insure that the results from various regions are comparable



Aerial view of the Salem nuclear plant, rated highly by the NRC's Region I.

Worker Exposure

Exposure of nuclear plant workers to radiation in 1982 continued at record highs, according to unpublished NRC data obtained by Public Citizen's Critical Mass. For the third year in a row, the total dose to the workforce exceeded 50,000 person-rems. The 1982 total dose figure of 52,190 person-rems was somewhat (3.5%) less than 1981's high of 54,142, but follows significant increases of 35% in 1980 and 20% in 1979.

Historically, the annual total dose to workers has increased more than forty-fold since 1969, when exposure totalled 1,247 person-rems, while the number of plants has increased only eleven-fold, from 7 to 74.

More plant workers were exposed to measurable doses of radiation in 1982 than ever before. A total of 84,322 workers were exposed, 2,139 more people than in 1981. These statistics indicate a trend within the nuclear industry to spread the risk of cancer and genetic damage to more workers every year. Because there is a legal limit on the amount of radiation exposure any one worker can receive, but no limit on how many people can be exposed to get a job done, the industry hires more and more workers every year to do its dirty work. Because of this, the number of exposed workers has increased dramatically — more than a hundred-fold since the NRC began collecting data in 1969.

The increasing number of temporary workers at nuclear plants is a serious problem. These employees are known as "jumpers" or "sponges" because they work in radioactive hot spots and soak up radiation as they make repairs. Utilities hire as many temporary workers as necessary to finish a job, then lay them off when they have absorbed the allowable radiation doses. There is an inherent economic and health inequity to these workers since full time employees generally receive less radiation but are entitled to full time salaries and benefits. The utilities do

Worker Radiation Exposure/Electric Power Produced: Sites with Ratios 15 or More Times Higher than the Lowest In 1982

Nuclear Site	1982 Ratio of Worker Exposure/ Electric Power[1]	Times Higher than Lowest 1982 Ratio[2]
San Onofre	13.5	67.5
La Crosse	11.9	59.5
Nine Mile Point	9.5	47.5
Big Rock Point	7.5	37.5
Indian Point 3	7.1	35.5
Brunswick 1/2	6.5	32.5
Robinson 2	5.1	25.5
Yankee Rowe	4.4	22.0
Pilgrim 1	3.9	19.5
Ginna	3.9	19.5
Quad Cities 1/2	3.7	18.5
Oyster Creek	3.6	18.0
Monticello	3.4	17.0
Indian Point 1/2	3.1	15.5

1. Total person-rems of radiation exposure divided by Megawatt-years of electricity produced at each site is a measure of the amount of worker radiation exposure per unit of power generated.

2. In 1982, Haddam Neck, Kewaunee, and Prairie Island 1/2 had the lowest worker radiation/power produced ratio, .20 person-rems/MW-year. The 1981 low was .10, at Davis-Besse.

to Radiation

not keep adequate records on temporary workers, and it takes the NRC two years to gather, analyze and publish the information specific to them. As of September, 1983, the most recent available data were for 1980. In that year, transient workers comprised 45 percent of the total workforce, a 35-fold increase since 1972.

What effect does exposure to radiation have on nuclear workers? Medical findings have conclusively linked radiation exposure with cancer and genetic damage, and there is no known safe threshold for radiation exposure. But because its damage is not manifest for as many as 30 years, radiation gets lost in the statistical crowd of other cancer-causing substances. Expert opinion varies on the number of deaths among nuclear workers that will result from their cumulative exposure in 1982 to more than 50,000 rems. Based on the figures of the National Academy of Science (NAS) Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR), there will be between three and ten additional cancer deaths. Other sources such as the Mancuso study of atomic workers, indicate the BEIR estimates may be too low by a factor of 30 or more.

Exposure to radiation has a cumulative health effect. Each additional year of radiation exposure increases the risk of leukemia and of cancer of the bone marrow, thyroid, breast, lung, etc. In addition to cancer, radiation exposure at low levels can cause genetic damage, birth defects, and miscarriages. A 1979 British study of nuclear dockyard workers showed three- and four-fold increases in chromosomal damage after exposures of 2-3 rems per year for 10 years.

Existing law allows radiation exposure of U.S. nuclear plant workers up to 5 rems annually, and as high as 12 rems in some cases. This is 30 to 70 times higher than the 0.17 rems recommended as the upper limit for the general public by the National Academy of Sciences' BEIR Committee. A dose of 5 rems is comparable to the amount of radiation in 250 chest X-rays. Dr. Edward Radford, former Chairman of the BEIR Committee, has called for a minimum reduction of the limit by ten-fold, down to 0.50 rems. In 1982, 29,395 U.S. nuclear plant workers (34.8 percent of those with measurable doses) were exposed to 0.50 rems or greater.

One index used by the NRC to compare the public benefits to the risks of nuclear power plants is the ratio of person-rems of radiation exposure to megawatt-years (MW-Yr) of power produced. This measures the total amount of worker radiation exposure divided by the amount of power generated at a particular site for a given year.

According to this yardstick, the best sites in 1982 were at Haddam Neck, Kewaunee, and Prairie Island 1/2. At San Onofre, the ratio was 13.5, or 67.5 times higher than at the best sites. This plant has had the worst occupational exposure record for each of the past three years. In addition to San Onofre, 13 other sites (listed in the table below) had exposure/power ratios more than 15 times higher than the best sites.

In order to protect the workforce, lower total levels of radiation exposure are needed, rather than just distributing the exposure to more people. The failure to set a ceiling on the total dose to the work force or the size of that work force, when combined with the high levels of allowable exposure to individuals, shows a callous disregard for the national health. The industry has created a genetic time bomb, the effects of which cannot be known for several generations.

A bibliography on low-level radiation is available for $1.00 from Critical Mass

WORKER EXPOSURE TO RADIATION IN 1982

Nuclear Site	Reactor Type	Collective 1982 Dose in Rems	Workers Exposed	Percentage of Exposed Workers Receiving 0.5 Rems or More
Arkansas 1/2	PWR	803	1608	29.73
Beaver Valley	PWR	599	1755	23.48
Big Rock Point	BWR	328	521	34.74
Browns Ferry 1/2/3	BWR	2220	3277	42.17
Brunswick 1/2	BWR	3792	4957	38.33
Calvert Cliffs 1/2	PWR	1057	1805	36.40
Cook 1/2	PWR	699	1527	32.22
Cooper Station	BWR	542	743	46.30
Crystal River 3	PWR	177	780	12.44
Davis-Besse	PWR	164	1350	4.89
Dresden 1/2/3	BWR	2923	2572	55.68
Duane Arnold	BWR	229	524	24.43
Farley 1/2*	PWR	484	1453	22.78
Fitzpatrick	BWR	1190	2322	36.30
Fort Calhoun	PWR	217	604	18.54
Ginna	PWR	1140	1117	54.43
Haddam Neck	PWR	126	559	10.73
Hatch 1/2	BWR	1460	3418	25.57
Humboldt Bay	BWR	19	71	15.49
Indian Point 1/2	PWR	1635	2144	46.08
Indian Point 3	PWR	1226	1477	47.05
Kewaunee	PWR	101	35[illegible]	18.70
La Crosse	BWR	205	148	58.1[illegible]
Maine Yankee	PWR	619	1295	32.82
McGuire 1*	PWR	169	1560	3.97
Millstone 1	BWR	929	1370	45.84
Millstone 2	PWR	1413	2083	45.61
Monticello	BWR	993	1307	40.09
Nine Mile Point	BWR	1264	1352	48.45
North Anna 1/2	PWR	1915	2872	30.78
Oconee 1/2/3	PWR	1792	2445	44.73
Oyster Creek	BWR	865	1270	41.73
Palisades	PWR	330	1554	11.07
Peach Bottom 2/3	BWR	1977	2734	45.14
Pilgrim 1	BWR	1539	2854	29.99
Point Beach 1/2	PWR	609	767	48.50
Prairie Island 1/2	PWR	229	645	22.48
Quad Cities 1/2	BWR	3757	2314	73.42
Rancho Seco	PWR	337	766	24.93
Robinson 2	PWR	1426	20[illegible]	36.20
St. Lucie	PWR	272	1045	15.31
Salem 1/2*	PWR	1203	3228	21.78
San Onofre 1/2	PWR	832	3055	17.98
Sequoyah 1*	PWR	570	1965	19.49
Surry 1/2	PWR	1490	1678	32.37
TMI 1/2	PWR	1004	2123	28.50
Trojan	PWR	419	977	25.08
Turkey Point 3/4	PWR	2119	2956	44.28
Vermont Yankee	BWR	205	481	31.19
Yankee Rowe	PWR	474	814	35.87
Zion 1/2	PWR	2103	157[illegible]	65.33
Totals and Industry Average		52190	84322	34.58

Source: Unpublished NRC documents obtained from the Management Information Branch, Office of Resource Management, NRC.

* Counted for the first time in 1982

THREATS TO NUCLEAR PLANTS — 1982

ZION (IL) 1/28/82
Videotape delivered to Chicago TV stations shows plant at night with flares going off. Individuals who claimed credit said they made tape to show plant's vulnerability to terrorist attack.

DAVIS-BESSE (OH) 1/29/82
Construction workers fired for drug use.

SHEARON-HARRIS (NC) 1/29/82
Employee arrested for theft of tools. Drugs found in his possession.

SHEARON-HARRIS (NC) 2/4/82
Quality-assurance inspector fired for drug use. Weld defects found when his work was re-inspected.

TURKEY POINT (FL) 2/4/82
7 security guards and 4 others implicated in drug use.

ZION (IL) 2/5/82
Security force supervisor and security force training coordinator suspended for drug use.

DRESDEN (IL) 2/12/82
Two employees fired for drug use.

KEWAUNEE (WI) 2/17/82
Intruder arrested trying to break into protected area.

PEACH BOTTOM (PA) 2/17/82
Site access of two employees removed for suspected drug use.

PALO VERDE (AZ) 2/19/82
Bomb threat.

PERRY (OH) 2/22/82
Factory-installed wires in emergency shutdown panel were cut.

PEACH BOTTOM (PA) 2/25/82
Security guard accidentally fired pistol.

NORTH ANNA (VA) 3/1/82
Bomb threat.

INDIAN POINT (NY) 3/5/82
An instrument containing 8 microcuries of radioactive cesium was found smashed in a bathroom in a controlled area.

TURKEY POINT (FL) 3/16/82
Bomb threat.

BRUNSWICK (NC) 3/19/82
Bomb threat.

ZIMMER (OH) 3/22/82
Bomb threat.

BRUNSWICK (NC) 3/23/82
Bomb threat.

DAVIS-BESSE (OH) 3/31/82
Employee fired for drug use.

ROBINSON (SC) 4/7/82
Bomb threat.

CALVERT CLIFFS (MD) 4/12/82
Bomb threat.

TURKEY POINT (FL) 4/14/82
Security guard accidentally shot himself in the leg.

PILGRIM (MA) 4/15/82
Two trucks in the contractor parking lot were fire-bombed.

MARBLE HILL (IN) 4/15/82-6/4/82
Sixteen bomb threats.

TURKEY POINT (FL) 4/21/82
Bomb threat.

RANCHO SECO (CA) 4/23/82
Bomb threat.

HATCH (GA) 4/26/82
.38 caliber revolver and ammunition taken into protected area.

SALEM (NJ) 4/28/82
Deliberately mispositioned valves caused a steam generator feedwater pump to trip while the plant was at 100% power.

SALEM (NJ) 5/1/82
Steam generator water level recorder was shorted by a metal clip.

FARLEY (AL) 5/5/82
Employee fired for drug use.

ZION (IL) 5/5/82
Military police arrested plant employee absent without leave from the Army.

BRUNSWICK (NC) 5/14/82
Twelve neutron detector tubes were found intentionally bent.

OCONEE (SC) 5/21/82
Arrest of two employees for drug use.

BELLEFONTE (AL) 5/26/82
Bomb threat.

BELLEFONTE (AL) 5/26/82
A bomb device, consisting of a piece of pipe filled with acetylene gas, was set off in the reactor building.

BRUNSWICK (NC) 5/26/82
Employee fired for drug use.

FORT CALHOUN (NB) 6/4/82
Employee reports to work with loaded gun in her purse.

FITZPATRICK (NY) 6/7/82
2 handguns taken onto site.

CRYSTAL RIVER (FL) 6/7/82
Loaded .32 caliber revolver found in employee's briefcase.

SUMMER (SC) 6/20/82
Bomb threat.

QUAD CITIES (IL) 6/29/82
3 employees investigated for drug use.

ZION (IL) 6/29/82
Drugs found in contractor's truck, which was denied access to the plant.

LIMERICK (PA) 6/30/82
Fire discovered in 2 cable trays. The cables were cut as well as burned, indicating a deliberate act.

WATERFORD (LA) 7/16/82
Fire set in cable room burned as many as 27 cables.

ARKANSAS (AR) 7/23/82
Police arrested a man with firearms, munitions and electronic components and a hand-drawn diagram of physical security at the plant.

CALVERT CLIFFS (MD) 7/26/82
Bomb threat.

CALVERT CLIFFS (MD) 7/29/82
Bomb threat.

SEABROOK (NH) 8/4/82
Bomb threat.

SALEM (NJ) 8/9/82
Plant tripped because a control system circuit breaker was placed in the "off" position, apparently deliberately.

COMANCHE PEAK (TX) 8/11/82
Sand found in turbine generator bearings.

SALEM (NJ) 8/16/82
Diesel generator valves found to have been shut.

SALEM (NJ) 9/3/82
Deliberate opening of valve led to release of 19 curies of Xenon-133 to atmosphere.

QUAD CITIES (IL) 9/15/82
Bomb threats.

SALEM (NJ) 10/21/82
Security monitor attempts suicide.

MILLSTONE (CT) 10/25/82
Bomb threat.

DIABLO CANYON (CA) 11/16/82
Arrest of guard for drug use.

MAINE YANKEE (ME) 11/18/82
Nuts, bolts and a cupful of metal chips were discovered in the oil reservoir from which the No. 1 reactor coolant pump is lubricated.

MILLSTONE (CT) 11/19/82
Bomb threat.

DIABLO CANYON (CA) 11/22/82
Federal agents arrested a man for possession of 3 destructive devices with intent to use them against Diablo Canyon.

TROJAN (OR) 12/17/82
Bomb threat.

DIABLO CANYON (CA) 12/30/82
Bomb threat.

Source: Events through June are from "Safeguards Summary Event List," NUREG-0525, Rev. 6 (1983). Events from July on are from NRC Preliminary Notifications of Safeguards Events (PNSs) and from a December 17, 1982, letter from NRC Chairman Nunzio J. Palladino to Rep. Edward J. Markey (D-MA).

Security Threats

Nuclear energy is a source of power that depends upon the smooth operation of a great number of complex mechanical systems that often malfunction even under the best circumstances. Because of this, nuclear power plants are especially vulnerable targets for saboteurs and terrorists.

The vulnerability of nuclear reactors was highlighted at a classified congressional hearing in September of 1982 in which horrified members of Congress learned of a governmental test of the physical security at the Savannah River Plant (SC) where plutonium for nuclear weapons is made. During the test, held in 1980, seven "terrorists" infiltrated the plant, seized hostages and took over the control room of one of the production reactors that makes plutonium. The management of the plant, which had been notified in advance that the test would take place, was so shaken by the ease of the takeover that they asked that the rest of the test be cancelled and turned it into a training exercise for the guard force.

Sabotage directed at vital safety systems of nuclear plants has increased markedly in recent years. These incidents, which the NRC euphemistically calls "vandalism," rose from one in 1980, to four in 1981, to six in 1982. Even worse, it is clear that all these acts of sabotage were carried out by plant insiders were responsible in all of these cases. Insiders know how to effectively disable the plant, and even a security system that carefully limits entry to only authorized people cannot keep them out.

The guard forces at nuclear plants have long been thought to be one of the weakest links in the overall security effort. A 1977 General Accounting Office study declared the quality of the guard forces to be "the greatest single shortcoming." Although a 1983 GAO study concludes that the situation has improved somewhat, there are clearly many continuing problems in this area. For example, at the Peach Bottom (PA) plant, a guard "accidentally" fired his gun. A subsequent study showed that it could not physically have happened the way the guard described it. And at Turkey Point (FL), a guard accidentally shot himself in the leg. Another serious problem with guard forces is drug use. At Diablo Canyon (CA) a guard was arrested for drug use, and at Turkey Point (FL) 7 guards were implicated in drug use. At Zion (IL) both the supervisor of the guard force and the head of guard training were disciplined for drug use.

Page 12 lists events in 1982 considered by the NRC as security threats. As we go to press, the NRC has still not finished evaluating the security threats from the last half of 1982, so the events listed for July through December were taken from preliminary reports, which may be incomplete. Some of the most disturbing events during 1982 that involved the safeguarding of nuclear plants are the following:

• At Limerick (PA) and also at Waterford (LA), electrical cables were damaged by deliberately set fires.

• At Salem (NJ), there was a series of sabotage events. In one, a vent line drain valve was tampered with, causing the release of radioactive Xenon-133 into the atmosphere. In another, valves that control the start-up of the emergency diesel generators were found closed. In another event, a metal clip had been used to short out the steam generator water level indicator. And in yet another, the plant had to be shut down because of an essential circuit breaker that had been placed in the "off" position, apparently deliberately.

• At Brunswick (NC), twelve neutron detection guide tubes had been bent where they leave the reactor vessel. NRC Chairman Palladino, in a February 7, 1983, letter to Rep. Edward J. Markey (D-MA), said that if this had not been discovered before the plant started up, "it would have represented a major degradation of essential safety-related equipment."

Police arrested a man with explosives and a diagram of security at the Arkansas plant. Separately, federal agents arrested a man with explosives near the Diablo Canyon plant.

• At about 1:30 am on January 28, 1982, a young woman delivered packages containing a note and a videotape to several Chicago area TV stations. The note said "This is a warning. The next time will be for real." The videotape showed the Zion (IL) plant site at night with flares going off. Local police had reported flares near the plant site the previous night.

• At Maine Yankee (ME), a cupful of metal chips, two nuts and two bolts were discovered inside the oil reservoir for the lube oil pumps for the No. 1 reactor coolant pump. If uncorrected, this could damage the reactor coolant pump and compromise plant safety.

• In two separate incidents, men were arrested with explosive devices and diagrams of nuclear plants (Diablo Canyon[CA] and Arkansas [AR]).

Because of the threat to public health and safety posed by security threats to nuclear plants, Rep. Markey has urged the NRC to officially designate sabotage as an "Unresolved Safety Issue."

1982 NRC Fines of Nuclear Utilities

$550,000 1/18/82
BOSTON EDISON (Pilgrim)
Breakdown in control of several safety-related activities, and failure to correct false statements made to NRC. Failure to assure that combustible gases could be controlled after a loss-of-coolant accident, and failure to notify NRC when design reviews revealed the problem. Failure to assure that isolation valves would close when needed. Material false statements to NRC about containment purging system compliance with regulations.

$50,000 3/29/82
GEORGIA POWER (Hatch 1)
Failure to review proposed system changes that would affect nuclear safety and reporting requirements.

$50,000 3/29/82
TENNESSEE VALLEY AUTHORITY (Sequoyah 2)
Exceeded limiting conditions for operation by failing to maintain adequate staff retraining program and failing to implement required procedures.

$50,000 5/7/82
TENNESSEE VALLEY AUTHORITY (Browns Ferry 1, 2 and 3)
Failure to maintain positive access control to vital areas and to take initiative in identifying potential problems.

$50,000 5/10/82
VIRGINIA ELECTRIC AND POWER CO. (Surry 1)
Exceeded limiting condition for operation. A technician failed to tell his supervisor he had removed fuses from instruments that warn of high steam flow in main steam lines. Unit brought on line with these instruments inoperable, and ran for 10 hours without condition being noticed.

$16,000 5/12/82
CONSUMERS POWER (Palisades)
Failure to maintain containment integrity during startup and to follow safety-related procedures during maintenance of control rod drive mechanism.

$50,000 6/3/82
PORTLAND GENERAL ELECTRIC CO. (Trojan)
Failed to repair deficiency which could have made emergency diesel generator inoperable. NRC first proposed $60,000 penalty.

$60,000 6/17/82
SOUTHERN CALIFORNIA EDISON (San Onofre 1)
Failure to maintain positive access control to vital areas as required by security plan.

$120,000 6/22/82
SACRAMENTO MUNICIPAL UTILITY DISTRICT (Rancho Seco)
Inoperable diesel generator and high pressure injection pump. Failure to properly return emergency equipment to service after testing.

$44,000 6/25/82
DUKE POWER (Oconee 1)
Failure to maintain tight supervision of procedures affecting plant safety.

$100,000 7/8/82
COMMONWEALTH EDISON (Zion 1)
Failure to adequately evaluate radiation hazards before entry into area beneath the reactor vessel. Employee whole-body radiation dose of 5 rems, exceeding legal limit.

$20,000 7/13/82
GEORGIA POWER (Hatch 1, 2)
Inadequate security procedures. Inadequate search before entering protected area allowed handgun and ammunition to be taken into protected area. Inadequate posting of guards.

$120,000 7/16/82
CAROLINA POWER AND LIGHT (Brunswick 1)
Failure to recognize a broken safety-related water level instrument and carry out proper procedures when it was discovered.

$112,000 8/9/82
NEBRASKA PUBLIC POWER DISTRICT (Cooper)
Failure to install and test the prompt public notification system by required deadline, and making false statements about it to the NRC on three separate occasions. Originally assessed at $300,000.

$40,000 8/13/82
IOWA ELECTRIC LIGHT AND POWER (Duane Arnold)
Failure of emergency diesel generator to start within design requirements and failure to test operability of equipment after maintenance.

$90,000 10/5/82
ILLINOIS POWER (Clinton)
Intimidation of quality control inspectors and massive breakdown of electrical quality control. Failure to adequately control contractor who was responsible for quality assurance program.

$40,000 10/15/82
VERMONT YANKEE POWER CO. (Vermont Yankee)
Operators did not know that high pressure injection system had operated during a plant transient until an hour later, resulting in false reports to NRC.

$40,000 10/27/82
PUBLIC SERVICE ELECTRIC AND GAS (Salem)
Inadequate security measures. Change in physical barrier was approved by security even though it compromised protection of vital area.

$40,000 11/30/82
GPU NUCLEAR CORP. (Oyster Creek)
Failure to properly test isolation valve and failure to properly install and test vacuum breaker. GPU appealed, claiming safety significance was minimal because redundant systems were operable. NRC said redundancy is not meant as "a substitute for good judgment or adequate procedures."

$20,000 12/6/82
LOUISIANA POWER AND LIGHT (Waterford 3)
Breakdown in quality-assurance program, resulting in numerous deficiencies and discrepancies, due to inadequate control of contractors.

$180,000 12/16/82
CONSOLIDATED EDISON (Indian Point 2)
Plant personnel exposed to 8.7 rems of radiation because of inadequate radiological surveys. Failure to assess effect on security of change to physical barrier. Failure to properly maintain Safety Injection System Boron Injection Tank.

$3,125 12/17/82
TENNESSEE VALLEY AUTHORITY (Browns Ferry 1, 2 and 3)
Two improper shipments of radioactive waste. Eight drums had cracked drum closing rings. Four others had unsecured gaskets, and one had two holes in it, probably caused by fork-life blades.

$50,000 12/27/82
FLORIDA POWER CORP. (Crystal River)
Failure to control access to a vital area and to maintain compensatory measures for an inadequate perimeter alarm system.

Fines

In 1982, the NRC levied almost $2 million in fines ($1,895,125) against nuclear power plant owners, for a variety of security and management failures. The fines imposed in 1982 ranged from a low of $3,125 against the Tennessee Valley Authority for shipping leaky drums of radioactive waste from its **Browns Ferry** (AL) plants, to a high of $550,000 against the Boston Edison Company for major deficiencies in management control over the **Pilgrim** (MA) plant.

The fine against Boston Edison was based on a series of management failures to comply with NRC regulations that require having a system to control the amount of hydrogen in the containment building following certain accidents. At a minimum, this required the Pilgrim plant to have a system to "purge" the containment to the atmosphere, and to make sure that the system could still work if there was a loss of offsite power of a single component.

Boston Edison not only failed to install an adequate system to control hydrogen in an emergency, but its officials falsely told the NRC that the system at Pilgrim met all of the NRC requirements. And when the company finally realized that its system was inadequate, it didn't tell the NRC about it or correct the earlier false statement.

A second violation at Pilgrim was the failure of the management to adequately control the maintenance of safety-related electrical power supplies. Because of this, there was no assurance that the containment isolation valves would work properly if they were needed to help mitigate the effect of a major accident. A third violation was that the containment "drywell" was being operated at temperatures far above the limit imposed by the plant's license to operate. This causes premature aging of important equipment needed to safely shut down the reactor and mitigate serious accidents. This condition has existed for years, and even after Boston Edison became aware of the problem, it failed to correct it. In fact, the NRC was able to point to safety-system failures at Pilgrim that were probably caused by this violation of the regulations.

The NRC viewed these recurring failures of management to pay adequate attention to safety at the Pilgrim plant as being so serious that it reported the management deficiency to Congress as an "Abnormal Occurrence." Abnormal Occurrences are events that involve "a major reduction in the degree of protection of the public health or safety."

Because of the time taken in reviewing potential fines, often they are not announced until much later than the original violation. For instance, in July of 1983 the NRC fined General Public Utilities Corporation, the owner of **Three Mile Island**, $140,000 because its reactor operators had cheated on NRC licensing examinations in 1981, and because GPU had lied to the NRC about a cheating incident that involved the Supervisor of Operations at TMI-2. Several other fines levied in 1983, which arose from violations in 1982, are of particular interest. Foremost among these is the assessment of $600,000 against Carolina Power and Light, owners of the **Brunswick** plants. The NRC found that the Brunswick plants had been operated, for as long as 7 years, without ever testing certain safety systems and components. Even worse, Carolina Power and Light had not corrected the problems even after they had been discovered. The NRC declared this breakdown in management control to be an "Abnormal Occurence" because it raised serious questions about whether operating the plant would endanger public health and safety.

Even the highest NRC fine in history is not as much of a penalty as the cost of being shut down for a single day.

Other recent fines based on 1982 violations include: $140,000 against Philadelphia Electric for insufficient management attention to plant safety at **Peach Bottom**; $100,000 against Commonwealth Edison for inadequate quality assurance for safety systems at **Braidwood**; and $100,000 against Niagara Mohawk, owners of **Nine Mile Point**, for falsification of documents.

Even though the NRC assessed Boston Edison and Carolina Power and Light with two of the highest fines in the history of nuclear power (the current highest is the $850,000 fine against Public Service Gas and Electric for the Anticipated Transient Without Scram at Salem 1), the actual amount is really little more than a slap on the wrist, because of the financial incentives facing a utility.

If a plant is shut down to repair some safety defect, the utility must buy replacement power from other utilities in order to maintain service to its customers. This replacement power can easily cost $1 million for each day the plant is shut down. Thus, even the highest NRC fine in history is not as much of a penalty as the cost of being shut down for a single day. It's easy to see why a utility would let a safety problem drag on, risking an NRC fine, rather than the larger and more immediate cost of shutting the plant down to fix the problem.

Until 1980, the situation was even worse: the NRC could only fine utilities $5,000 for violating its rules. Although the current limit of $100,000 per violation (which can be increased by defining each day's violation as a separate offense) is a big improvement, it is still thoroughly inadequate to give utilities the necessary financial incentive to obey the NRC's regulations.

PLANT SCORECARD

AC — Allis-Chalmers. **BW** — Babcock & Wilcox. **CE** — Combustion Engineering. **GA** — General Atomic. **GE** — General Electrical. **W** — Westinghouse. **BWR** — Boiling Water Reactor. **PWR** — Pressurized Water Reactor. **HTG** — High Temperature Gas Cooled Reactor. **MWe** — Design Electrical Rating (**DER**), expressed in Megawatts-electric. **Capacity Factor** — the percentage of the maximum potential electrical output which the plant achieved, in 1982 and since the **Year** in which the plant began commercial operations

Plant	Location	Licensee	Vendor	Type	MWe	Human Error	Design/Manufacturing Error	Equipment Failure	Other Cause	Particularly Significant Mishaps	Total 1982 Mishaps	Capacity Factor 1982	Capacity Factor Lifetime	Year
Arkansas 1	Russellville, AR	Arkansas Power & Light	BW	PWR	850	10	9	11	0	5	30	50.0	58.5	1974
Arkansas 2	Russellville, AR	Arkansas Power & Light	CE	PWR	912	12	15	21	2	3	50	47.7	53.2	1980
Arnold	Palo, IA	Iowa Electric Power & Light	GE	BWR	538	19	27	36	1	2	83	48.4	50.7	1975
Beaver Valley 1	Shippingport, PA	Duquesne Light	W	PWR	852	13	16	29	3	3	61	36.0	35.8	1976
Big Rock Point	Big Rock Point, MI	Consumers Power	GE	BWR	72	10	7	18	0	1	35	57.1	53.4	1963
Browns Ferry 1	Decatur, AL	Tennessee Valley Authority	GE	BWR	1065	25	12	57	2	2	96	84.5	53.6	1974
Browns Ferry 2	Decatur, AL	Tennessee Valley Authority	GE	BWR	1065	9	8	19	0	1	36	47.7	53.1	1975
Browns Ferry 3	Decatur, AL	Tennessee Valley Authority	GE	BWR	1065	14	4	34	2	1	54	52.4	64.2	1977
Brunswick 1	Southport, NC	Carolina Power & Light	GE	BWR	821	37	30	81	2	6	150	40.6	48.5	1977
Brunswick 2	Southport, NC	Carolina Power & Light	GE	BWR	821	40	32	65	4	10	141	26.6	40.9	1975
Calvert Cliffs 1	Lusby, MD	Baltimore Gas & Electric	CE	PWR	845	23	22	36	4	4	85	72.4	70.0	1975
Calvert Cliffs 2	Lusby, MD	Baltimore Gas & Electric	CE	PWR	845	17	8	29	0	3	54	67.6	75.3	1977
Cook 1	Bridgman, MI	Indiana & Michigan Electric	W	PWR	1054	45	19	46	3	1	113	58.0	64.1	1975
Cook 2	Bridgman, MI	Indiana & Michigan Electric	W	PWR	1100	34	24	52	6	1	116	72.6	67.8	1978
Cooper 1	Brownsville, NB	Nebraska Public Power	GE	BWR	778	8	5	13	0	0	26	77.4	63.1	1974
Crystal River 3	Red Level, FL	Florida Power	BW	PWR	825	19	23	33	2	4	77	68.0	54.2	1977
Davis-Besse 1	Oak Harbor, OH	Toledo Edison	BW	PWR	906	30	14	22	1	4	67	40.5	40.2	1978
Diablo Canyon	Avila Beach, CA	Pacific Gas & Electric	W	PWR	1084	4	4	4	0	1	12	License Suspended		
Dresden 2	Morris, IL	Commonwealth Edison	GE	BWR	794	13	9	29	2	2	53	73.7	56.9	1970
Dresden 3	Morris, IL	Commonwealth Edison	GE	BWR	794	7	8	30	0	1	45	55.9	56.6	1971
Farley 1	Dothan, AL	Alabama Power	W	PWR	829	14	4	44	1	1	63	71.8	55.3	1977
Farley 2	Dothan, AL	Alabama Power	W	PWR	829	15	5	33	0	5	53	72.9	79.4	1981
Fitzpatrick	Scriba, NY	PASNY	GE	BWR	821	19	10	27	5	4	61	69.0	57.7	1975
Ft. Calhoun	Ft. Calhoun, NB	Omaha Public Power	CE	PWR	478	2	5	12	1	1	20	83.2	62.7	1974
Ft. St. Vrain	Ft. St. Vrain, CO	Public Service of Colorado	GA	HTG	330	16	6	30	2	2	54	19.7	20.9	1979
Ginna	Ontario, NY	Rochester Gas & Light	W	PWR	470	11	11	5	0	2	27	58.5	68.6	1970
Grand Gulf 1	Vicksburg, MS	Mississippi Power & Light	GE	BWR	1250	58	22	59	46	2	185	Testing		
Haddam Neck	Haddam Neck, CT	Connecticut Yankee Atomic	W	PWR	582	2	4	4	0	1	10	89.0	76.6	1968
Hatch 1	Baxley, GA	Georgia Power Co.	GE	BWR	777	40	14	43	2	4	99	42.3	54.3	1975
Hatch 2	Baxley, GA	Georgia Power Co.	GE	BWR	784	50	12	74	3	7	139	54.3	59.6	1979
Humboldt Bay	Eureka, CA	Pacific Gas & Electric	GE	BWR	65	1	2	4	0	0	7	Shut Down		
Indian Point 2	Buchanan, NY	Consolidated Edison	W	PWR	873	6	9	33	2	4	50	58.2	54.9	1974
Indian Point 3	Buchanan, NY	PASNY	W	PWR	965	0	1	2	1	2	4	17.0	47.0	1976
Kewaunee	Carlton, WI	Wisconsin Public Service	W	PWR	535	5	9	20	3	1	37	81.6	75.9	1974
LaCrosse	LaCrosse, WI	Dairyland Power Co-op	AC	BWR	50	6	5	9	0	2	20	31.5	45.5	1969
LaSalle 1	Ottawa, IL	Commonwealth Edison	GE	BWR	1078	55	21	74	2	5	152	Testing		
Maine Yankee	Wiscasset, ME	Maine Yankee Power	CE	PWR	825	12	11	15	2	4	40	62.6	65.6	1972

McGuire 1	Cornelius, NC	Duke Power Co.	W	PWR	1180	36	17	28	2	8	83	41.6	38.5	1981
Millstone 1	Waterford, CT	Northeast Nuclear Energy	GE	BWR	660	5	6	21	0	5	32	70.5	62.4	1971
Millstone 2	Waterford, CT	Northeast Nuclear Energy	GE	BWR	870	17	13	20	3	1	53	65.7	64.2	1975
Monticello	Monticello, MN	Northern States Power	GE	BWR	545	5	5	4	0	3	14	50.7	70.5	1971
Nine Mile Point	Scriba, NY	Niagara Mohawk Power	GE	BWR	620	5	7	8	4	2	24	20.9	57.8	1969
North Anna 1	Mineral, VA	Virginia Electric Power	W	PWR	907	16	18	49	5	8	88	30.2	56.4	1978
North Anna 2	Mineral, VA	Virginia Electric Power	W	PWR	907	30	19	30	7	4	86	50.9	61.7	1980
Oconee 1	Seneca, SC	Duke Power Co.	BW	PWR	887	11	4	5	0	3	20	66.3	57.8	1973
Oconee 2	Seneca, SC	Duke Power Co.	BW	PWR	887	4	6	1	1	4	12	44.2	58.4	1974
Oconee 3	Seneca, SC	Duke Power Co.	BW	PWR	887	4	8	2	0	7	14	27.2	60.0	1974
Oyster Creek	Toms River, NJ	GPU Nuclear Corp.	GE	BWR	650	20	8	34	0	4	62	35.4	59.4	1969
Palisades	South Haven, MI	Consumer Power	CE	PWR	805	11	10	26	2	6	49	47.4	38.3	1971
Peach Bottom 2	Peach Bottom, PA	Philadelphia Electric	GE	PWR	1065	14	5	25	0	2	44	51.4	62.3	1974
Peach Bottom 3	Peach Bottom, PA	Philadelphia Electric	GE	PWR	1065	8	1	18	0	1	27	91.5	64.4	1974
Pilgrim 1	Plymouth, MA	Boston Electric	GE	BWR	655	26	6	20	3	7	55	57.3	57.1	1972
Point Beach 1	Two Creeks, WI	Wisconsin Electric Power	W	PWR	497	11	8	8	0	2	27	62.1	69.8	1970
Point Beach 2	Two Creeks, WI	Wisconsin Electric Power	W	PWR	497	6	3	2	0	0	11	82.8	79.3	1972
Prairie Island 1	Red Wing, MN	Northern States Power	W	PWR	530	6	1	6	0	1	13	84.4	70.7	1973
Prairie Island 2	Red Wing, MN	Northern States Power	W	PWR	530	3	1	7	0	0	11	83.1	75.7	1974
Quad Cities 1	Cordova, IL	Commonwealth Edison	GE	BWR	789	6	9	22	0	2	37	46.9	59.6	1973
Quad Cities 2	Cordova, IL	Commonwealth Edison	GE	BWR	789	3	3	15	0	3	21	73.2	59.3	1973
Rancho Seco	Clay Station, CA	Sacramento Municipal	BW	PWR	918	11	8	11	4	5	34	41.9	49.2	1975
Robinson 2	Hartsville, SC	Carolina Power & Light	W	PWR	700	8	4	6	0	4	18	36.7	63.2	1971
St. Lucie 1	Ft. Pierce, FL	Florida Power & Light	CE	PWR	830	14	8	45	3	[illegible]	70	94.4	73.5	1976
Salem 1	Salem, NJ	Public Service Electric	W	PWR	1090	30	9	49	5	6	93	42.9	46.8	1977
Salem 2	Salem, NJ	Public Service Electric	W	PWR	1115	31	37	83	6	10	157	81.3	80.4	1981
San Onofre 1	San Clemente, CA	Southern California Edison	W	PWR	436	12	7	6	0	5	25	13.4	56.2	1968
San Onofre 2*	San Clemente, CA	Southern California Edison	CE	PWR	1087	46	54	70	0	5	170	Testing		
San Onofre 3	San Clemente, CA	Southern California Edison	CE	PWR	1100	7	0	3	0	1	10	Testing		
Sequoyah 1	Daisy, TN	Tennessee Valley Authority	W	PWR	1148	16	13	48	3	4	80	49.0	49.2	1981
Sequoyah 2	Daisy, TN	Tennessee Valley Authority	W	PWR	1148	15	14	38	0	1	67	66.6	66.6	1982
Summer 1	Columbia, CA	South Carolina Electric & Gas	W	PWR	900	22	6	36	2	0	66	Testing		
Surry 1	Gravel Neck, VA	Virginia Electric Power	W	PWR	788	25	36	59	1	4	121	79.4	54.2	1972
Surry 2	Gravel Neck, VA	Virginia Electric Power	W	PWR	788	12	16	42	1	2	71	79.6	56.0	1973
Susquehanna 1	Berwick, PA	Pennsylvania Power and Light	GE	BWR	1011	39	13	28	0	1	80	Testing		
Three Mile Is. 1	Middletown, PA	GPU Nuclear Corp.	BW	PWR	819	6	3	6	1	0	16	00.0	39.9	1974
Three Mile Is. 2	Middletown, PA	GPU Nuclear Corp.	BW	PWR	906	7	6	20	1	1	34	Shut Down		
Trojan	Prescott, OR	Portland General Electric	W	PWR	1130	11	5	6	0	7	22	48.5	51.5	1976
Turkey Point 3	Florida City, FL	Florida Power & Light	W	PWR	693	9	0	9	1	3	19	62.0	59.8	1972
Turkey Point 4	Florida City, FL	Florida Power & Light	W	PWR	693	6	4	4	0	3	14	63.3	64.6	1973
Vermont Yankee	Vernon, VT	Vermont Yankee Nuclear	GE	BWR	514	7	3	16	0	3	26	92.7	70.2	1972
Yankee Rowe	Rowe, MA	Yankee Atomic Electric	W	PWR	175	7	12	20	3	1	42	57.5	68.9	1961
Zion 1	Zion, IL	Commonwealth Edison	W	PWR	1040	12	4	34	1	4	51	51.5	58.4	1973
Zion 2	Zion, IL	Commonwealth Edison	W	PWR	1040	5	3	18	0	5	26	56.6	58.1	1974
					TOTAL	1306	870	2161	163	253	4500			

Particularly Significant Mishaps

The following list briefly describes each of the 253 nuclear plant mishaps that was counted as a particularly significant mishap for 1982. Every one of these mishaps was addressed in one or more NRC documents that discuss significant safety-related nuclear power plant mishaps. (Because of differences in methodology, the total number of "particularly significant mishaps" is not directly comparable to the total number of "especially significant mishaps" in last year's report. Methodology is described on page 30.)

ARKANSAS 1

04/10 — Hydrogen explosion during repair of high pressure injection nozzle. M6, P3, N82-28.

05/11 — Hydrogen purge system inoperable due to water saturated filter. LER 313-82-010, E.

05/25 — Steam generator tube leak from crack caused either by corrosion or vibration. LER-313-82-012, M8.

12/3 — Torrential rains partially flooded sumps of turbine building and auxiliary building. P7.

12/16 — Inoperable containment atmosphere sensing system, due to personnel error. LER-313-82-031, N83-23.

ARKANSAS 2

04/15 — Leakage in the "B" steam generator blowdown line, caused by steam erosion and accelerated because the wrong piping had been used, occurred. LER-368-82-011, M6.

08/20 — Leakage of the primary manway of the steam generator. LER-368-82-028, M12.

10/18 — Safety injection check valve stuck open. LER-368-82-008, M3.

ARNOLD

01/21 — Water hammer disabled low pressure coolant injection system and service water system of residual heat removal system. LER-331-82-008, M3.

06/02 — Main steam isolation valve position switch failed. Subsequent inspection showed cracked hydraulic cylinders and broken control valve cap screws. LER-331-82-034, M9, P4, E.

BEAVER VALLEY

01/19 — Steam generator drain tank recirculation line cracked because of internal freezing. LER-334-82-002, P5.

01/27 — During shutdown, backup residual heat removal pump failed because of loss of offsite power due to faulty cable and because emergency diesel generator was out of service for maintenance. LER-334-82-004, M2, P3, E.

10/18 — Reactor trip, partial loss of offsite power. P6.

BIG ROCK POINT

01/07 — Because of faulty switch, control rods began to drift into core. Operator then scrammed reactor manually. M1.

BROWNS FERRY 1

09/22 — Because of annunciator failure, plant falsely declared an alert. Affected Units 2 and 3 also. M14.

12/00 — Rupture of 18 inch feedwater pipe. M18.

BROWNS FERRY 2

07/23 — High pressure coolant injection system switches inoperable. LER-260-82-023, E.

BROWNS FERRY 3

09/28 — Because of annunciator failure, plant falsely declared an alert. Affected Units 1 and 2 also. M14.

BRUNSWICK 1

02/11 — Unsoldered wiring caused spurious actuation of reactor protection system and emergency core cooling system. Same event occurred three more times the next day. LER-325-82-023, M3.

02/16 — Personnel error led to spurious actuation of emergency core cooling system. M3.

07/01 — Sheared dowel pins and screws disabled the emergency diesel generators. LER-325-82-078, P5, E.

06/28 — Reactor tripped after important power supplies lost voltage. Post-trip analysis revealed that undervoltage relays were not being inspected as required by the plant's operating license. This incident contributed to a $600,000 fine imposed by NRC in 1983. LER-325-82-072, AO-83-2.

07/23 — Incorrect test procedures had been failing to check valves in fire protection systems. LER-325-82-083, P5.

10/00 — Safety relief valve failed to close. Other safety relief valves also found inoperable. M16.

BRUNSWICK 2

01/11 — Frozen pipes led to excess oxygen concentrations in drywell. LER-324-82-004, P5.

01/16 — Residual heat removal system inoperable. LER324-82-005, P2, M1.

02/04 — Main steamline high flow sensing equipment inoperable. N82-13.

03/01 — High pressure coolant injection system inoperable because of switch failure. LER-324-82-044, E.

05/20 — Crack found in core spray equipment. M8.

07/27 — Isolation valve not tested due to personnel error. LER-324-82-091, P5.

07/27 — Incorrect testing of reactor water isolation timing. LER-324-82-097, P5.

08/02 — Failure to adequately test core spray system and low pressure coolant injection system. LER-324-82-100, P5.

10/10 — Failure of a circuit breaker led to loss of emergency power. LER-324-82-123, P6.

10/29 — Pipe crack in the residual heat removal system. LER-324-82-130, M17.

CALVERT CLIFFS 1

05/14 — Steam generator leak from 7 tubes, which were then plugged. LER-317-82-023, M8.

06/02 — Loss of all emergency diesel generators. LER-317-82-027, P4.

06/18 — Inoperable containment atmosphere sensing system. N83-23.

11/01 — Unusually large number of actuations of engineered safety features (12 between 11/1/82 and 1/12/83, counting Unit 2 as well). M19.

CALVERT CLIFFS 2

06/02 — Loss of all emergency diesel generators. LER-318-82-025, M9, P4.

07/20 — Plant reduced power because a broken valve led to failure of both salt-water heat-exchangers. LER-318-82-034, M11, E.

11/01 — Unusually large number of actuations of engineered safety features (see Unit 1 listing). M19.

COOK 1

07/02 — Foreign objects found in steam generators, including 6 inch ball of wire, two bronze lock nuts, metal object the size of a half dollar, and parts of a pocket knife. M11, N83-24.

COOK 2

12/29 — Low water flow in emergency core cooling system caused by loose object in system, possibly left there during repairs in 1981. LER-316-82-113, M19, E.

CRYSTAL RIVER 3

01/21 — .9 gallon per minute leak from check valve in high pressure injection system. N82-09.

01/29 — Reactor coolant pump leak, caused by cracked weld, forced plant to shut down. LER-302-82-004, M2, P2.

05/10 — Vibration in the makeup system repeatedly led to cracked welds. LER-302-82-037, E.

11/25 — Improper setting of effluent monitors leads to release of radiation beyond legal limits. LER-302-82-073, P7.

DAVIS-BESSE

04/00 — 50 blades in the low pressure turbine were found cracked, 9 of them seriously. M6.

04/19 — Auxiliary feedwater header was damaged by cold water, and parts of the header came loose inside the steam generator. LER-346-82-019, M6, P3, A3, E.

06/04 — Valves in 3 of 4 high pressure injection lines inoperable. LER-346-82-023, M9, N82-35.

08/14 — Defective bolt on emergency diesel generator sheared off during maintenance and would not have withstood seismic event. LER-346-82-038, E.

DIABLO CANYON

00/00 — Pressure differentials in gas monitoring system. N82-49.

DRESDEN 2

10/00 — Inoperable containment atmosphere sensing system. N83-23.

12/03 — Plant shut down and Alert declared because of heavy flooding near site. LER-237-82-050, P7.

DRESDEN 3

12/03 — Plant shut down, and Alert declared, because of heavy flooding near site. P7.

FARLEY 1

05/10 — Containment spray system inoperable. LER-348-62-021, M8.

FARLEY 2

01/11 — Main feedwater flow transmitter inoperable due to frozen sensing lines. LER-364-82-002, P5.

01/11 — Refueling water storage tank level transmitter failed due to freezing. LER-364-82-003, P5, E.

01/11 — Main steam line pressure transmitter inoperable due to frozen sensing lines. LER-364-82-004, M1, P5, E.

10/28 — Inoperable containment spray system. LER-364-82-043, P6, AO-82-7.

12/00 — Manual containment spray isolation valves found in wrong position. M17.

FITZPATRICK

02/10 — Incorrect calibration, since 1974, of high pressure injection system turbine steam line high flow instrument. LER-333-82-001, M3, M4, N82-16.

05/14 — Containment spray system inoperable. LER-333-82-023, E.

08/00 — Inoperable safety relief valves. M12.

08/23 — Two emergency diesel generators inoperable. LER-333-82-039, E.

FORT CALHOUN

08/30 — Containment isolation valves inoperable. N83-08.

FORT St. VRAIN

06/05 — Improperly calibrated undervoltage relay led to partial loss of power and manual reactor scram. LER-267-82-024, M9.

12/08 — Steam generator tube leak. LER-267-82-049, M18.

GINNA

01/25 — Steam generator tube rupture. LER-244-82-003, M2, P2, AO-82-4.

10/01 — Rupture of plugged steam generator tube. M15.

GRAND GULF

00/00 — Various failures of isolation valves. N82-25.

10/05 — Voltage spike actuated emergency core cooling system, causing a pressurized thermal shock pressure transient. M14.

HADDAM NECK

09/17 — Through-wall cracks in battery power supply. M14, N83-11.

HATCH 1

04/24 — Chemistry of primary coolant violates regulations due to impurities. LER-321-82-028, M7, P3, N82-32, E.

07/03 — During a reactor scam, 11 safety relief valves failed to actuate. LER-321-82-060, M10, P5, N82-41, A3, E.

09/24 — High pressure coolant injection system failed. LER-321-82-088, M14.

10/26 — Piping cracked in residual heat removal system. LER-321-82-089.

HATCH 2

03/12 — The pilot sensing tube was missing from the main steam safety relief valve. LER-366-82-023, E.

06/17 — Residual heat removal pump failed to achieve rated flow. LER-366-82-061, E.

06/27 — Residual heat removal water pump failed to achieve rated flow. LER-366-82-059, E.

08/25 — Main steam isolation valve (MSIV) spontaneously closed, causing plant to shut down. LER-366-82-081, M12.

08/25 — Safety relief valve inoperable. LER-366-82-091, E.

08/28 — Reactor core isolation cooling system inoperable. LER-366-82-100, E.

10/17 — Inoperable containment atmosphere sensing system. N83-22.

INDIAN POINT 2

02/17 — Emergency battery failure. LER-247-82-007, N83-11.

04/23 — Emergency battery failure. LER-247-82-016, N83-11.

06/01 — Worker received 8.7 rems of radioactivity in the head while checking the fuel storage pool. N82-31.

10/00 — Possible cracks of steam generator. M16.

INDIAN POINT 3

03/24 — Steam generator leaks. LER-286-82-001.

03/27 — Steam generator leaks. LER-286-82-002, A2, N82-37.

KEWAUNEE

10/05 — Inoperable containment pressure sensing lines. LER-305-82-030, M15, N83-23.

LA CROSSE

09/10 — Core spray system blocked by silt and mud. M13.

09/26 — Blown fuse scrammed reactor and caused spurious safety system operation. M14.

LASALLE 1

05/15 — Inoperable radiation monitor. LER-373-82-021, E.

07/26, — Reactor core isolation cooling check valves fail to close. LER-373-82-077.

08/16 — Reactor core isolation valves fail to close. LER-373-82-097, M12.

08/30 — Reactor core isolation valves fail to close. LER-373-82-096, M12.

12/31 — Automatic depressurization system valves inoperable. "B" residual heat removal system inoperable. LER-373-82-178, M19.

MAINE YANKEE

01/28 — Safety injection actuation system design error. LER-309-82-002, M2, P3.

03/10 — Six steam generator manway studs were found broken. LER-309-82-005, M4, M6, N82-06, B.

10/00 — Swollen spent fuel racks, possibly from hydrogen formation, caused fuel binding. N83-29.

12/09 — Inoperable excore neutron detectors. LER-309-82-039, M18.

MCGUIRE

01/11 — Instrument lines frozen, causing spurious actuation of emergency safety features. LER-369-82-007, M1, P5, E.

02/12 — Loss of all three centrifugal charging pumps. LER-369-82-015, M3, N82-19, A2, E.

03/02 — Loss of all residual heat removal. LER-369-82-024, E.

03/08 — Debris found in steam generator. M4.

04/23 — Emergency diesel generator failure led to reactor shutdown. LER-369-82-030, E.

06/05 — Inoperable power operated relief valve. LER-369-82-048, E.

06/13 — 2 of 3 reactor protection system channels inoperable, reactor shut down. LER-369-82-052, M9.

07/05 — Reactor coolant system thermal sleeve missing. LER-369-82-056, M10, N82-30.

KEY

DATE: The date of the event. "00" indicates that NRC sources discussing event did not give a more specific date.

LER NUMBER: Utilities do not always report every important event, but if a licensee event report (LER) for an event could be found, its citation is given (the first number is the NRC's docket number for that plant, followed by the year and the event number).

NRC SOURCE: The various source documents consulted in compiling this list are represented as follows:

M: The Operating Reactor Events meetings held among top NRC safety staff on a regular basis. The meetings to discuss 1982 events were held on the following dates: M1, 01/22; M2, 02/11; M3, 03/03; M4, 03/17; M5, 03/31; M6, 04/21; M7, 05/05; M8, 05/27; M9, 06/16; M10, 07/07; M11, 08/11; M12, 09/08; M13, 09/15; M14, 09/29; M15, 10/13; M16, 10/27; M17, 11/24; M18, 12/16; M19, 01/13/83. Copies of memoranda summarizing each of these meetings can be found at the NRC Public Document Room, filed under FOIA-83-266.

P: The NRC publication, *Power Reactor Events*, NUREG/BR-0051, Volume 4. The issue number follows the "P". Each issue covers two months of 1982's events: P2, Jan.-Feb.; P3, Mar.-Apr.; P4, May-Jun.; P5, Jul.-Aug.; P6, Sep.-Oct.; P7, Nov.-Dec.

A: The NRC's *Report to Congress on Abnormal Occurances*, NUREG-0090, Vol. 5. The issue number follows the "A". Each issue covers three months of 1982: A1, Jan.-Mar.; A2, Apr.-Jun.; A3, Jul.-Sep.; A4, Oct.-Dec. Those events officially designated as "Abnormal Occurrences" are listed as "AO" followed by the NRC's Abnormal Occurrence number. AO's 82-3 and 82-4 are in A1, 82-5 is in A3, and 82-7 is in A4. AO-83-2 is from Vol. 6, No. 1, Jan.-Mar. 1983. The others were not 1982 events or were unrelated to nuclear power.

N: The NRC Office of Inspection and Enforcement's "Information Notices." The specific number of the Notice is given after the "N".

B: The NRC Office of Inspection and Enforcement's "Information Bulletin" number 82-02.

E: A computer printout from the NRC Office for the Analysis and Evaluation of Operational Data, which listed certain events as particularly significant.

All of these documents are available for public inspection at the NRC Public Document Room, 1717 H St. N.W., Washington, D.C. 20555.

MILLSTONE 1

02/24 — 5 GE relays failed to actuate because they had partially melted. LER-245-82-005, M3.

03/18 — 3 valves inoperable due to water damage. LER-245-82-008, E.

09/25 — Cracked weld in core spray system. LER-245-82-018, M14.

09/27 — Safety relief valves fail. LER-245-82-019, M14.

11/15 — Actuation of emergency core cooling system resulted in pressurized thermal shock transient. M17.

MILLSTONE 2

01/06 — Loss of cooling functions during shutdown. LER-336-82-002, E.

MONTICELLO

09/30 — Pipe cracks discovered in jet pump. M15.

10/09 — Cracks found in recirculation piping. LER-263-82-016, M17.

11/02 — Cracks found in recirculation piping. LER-263-82-013, M17.

NINE MILE POINT

03/23 — Cracks found in recirculation piping. LER-220-82-009, M5, M6, N82-3, N82-39, E.

09/09 — Pipe cracking found in emergency isolation condenser return line and shutdown cooling return line. M13.

NORTH ANNA 1

03/29 — 6 electronic relays had improper latching mechanisms. LER-338-82-008, E.

05/17 — Loose parts found in steam generator. LER-338-82-052, M8, M9, M11.

05/17 — Failure of control rod drive guide tube pins. N82-29, A2.

05/19-22 — Inoperable overpressure protection system. P4.

11/16 — Main transformer failed. A hole was blown in the transformer's case, and oil was sprayed into adjacent area. P7.

12/05 — Main transformer failed. Reactor and turbine tripped. P7.

12/06 — Both automatic safety injection systems were inoperable for almost 24 hours. LER-338-82-082, E.

12/07 — Emergency core cooling system actuated by mistake. LER-338-82-088, E.

NORTH ANNA 2

03/08 — Multiple pilot operated relief valve failures. LER-339-82-009, E.

03/10 — Feedwater and boron injection recirculation valves reopened in spite of containment isolation signal. LER-339-82-010, E.

04/00 — Steam generator tube degradation. M6.

08/22 — Transformer failed, spraying hot oil and triggering fire protection water deluge system. LER-339-82-053, M12, P7.

OCONEE 1

03/23 — Inoperable containment atmosphere sensing system. LER-269-82-008, N83-23, E.

05/21 — Overpressure transient. M9.

10/14 — Safety relief valves inoperable due to design problem. LER-269-82-018, M16.

OCONEE 2

03/00 — Cracked makeup nozzle. M6, P2.

03/02 — Cracked high pressure injection nozzle. LER-270-82-004, E.

06/28 — Steam line ruptured, injuring three workmen. M10, P5, N82-22, A3.

10/14 — Pressurizer safety valve malfunction. P6.

OCONEE 3

02/26 — Cracked high pressure injection nozzle, displaced thermal sleeves. LER-287-82-004, E.

03/00 — Cracked makeup nozzle. M6, P2.

04/30 — Both auxiliary feed water headers deformed. LER-287-82-006, P3, A2, E.

06/09 — Thermal shield bolt heads broke off. LER-287-82-008, E.

10/10 — Steam generator tube leak. M17.

11/17 — Steam generator tube leak. LER-287-82-012, M17.

12/11 — Steam generator tube leak. LER-287-82-014, M18.

OYSTER CREEK

01/09 — Overheated, smoking motor triggered water deluge system, which shorted out various instruments. M1.

02/18 — Overheated bearings triggered water deluge system, which shorted out parts of emergency core spray system and containment isolation instrumentation. LER-219-82-010, E.

08/14 — Salt water heat exchangers clogged by sealife. LER-219-82-0005, M12.

12/00 — Repeated reactor scrams due to excessive valve leakage. M18, P7.

PALISADES

00/00 — Severe damage to check valves in low pressure injection system. N82-20.

02/04 — Cooling tower pump trips, triggering reactor trip, steam line atmospheric dump and low pressure safety injection. M2.

02/04 — Hydrogen explosion in main generator starts fire, injures workman and damages turbine building wall. M2.

04/23 — Steam generator tube leaks. 2 tubes plugged. LER-255-82-012, M5.

08/19 — Degraded control rod drive mechanism. M13.

08/19 — Potential for loss of service water pump during a loss of coolant accident. LER-255-82-024, E.

PEACH BOTTOM 2

06/19 — Design problem with Unit 2 electrical system triggers emergency core cooling system at Unit 3. M10, M12, P5, N83-04.

10/24 — Safety relief valve spontaneously opens, leads to reactor scram. LER-277-82-036, M16, N83-26.

PEACH BOTTOM 3

06/19 — Emergency core cooling system triggered by reactor trip at Unit 2. M10, M12, P5.

PILGRIM

01/18 — Frozen sensing lines. LER-293-82-002, P5.

01/18 — Breakdown in plant safety management declared an Abnormal Occurence. $550,000 fine assessed: AO-82-3.

04/05 — Inconsistent water level readings. M6.

06/03 — Incore probe became stuck, causing high local radiation. P4.

06/11 — Radioactive resin found on the ground outside the turbine building. M9.

10/12 — Loss of offsite power due to heavy ocean storm. LER-293-82-051, M15.

10/13 — Loss of offsite power due to heavy ocean storm. LER-293-82-051, M16.

POINT BEACH 1

01/07 — Steam generator pressure sensing lines frozen. LER-266-82-001, M1, P5.

11/11 — Steam generator tubes damaged by loose 6 inch "C" clamp, 58 inch metal bar and other loose parts. LER-266-82-022, N83-24.

PRAIRIE ISLAND 1

08/27 — Human error disabled emergency diesel generator. LER-282-82-015, E.

QUAD CITIES 1

06/22 — Both diesel generators inoperable. LER-254-82-012, P5, AO82-5.

11/00 — Cracked feedwater nozzles. M17.

QUAD CITIES 2

01/15 — Reactor coolant system leak due to cracked weld. LER-265-82-001, M1.

06/22 — Loss of offsite power and backup diesel generator power. M10, P5, AO82-5.

10/21 — Recirculation pump valve failure. LER-265-82-019, P7, E.

RANCHO SECO

04/05 — Cracked makeup nozzle. LER-312-82-009, M6, P2, E.

04/19 — Deformed auxiliary feed water headers. LER-312-82-010, P3, A2, E.

07/15 — 15 reactor building polar crane bolts fail. LER-312-82-017, E.

11/21 — Steam generator tube leak. LER-312-82-031, M17.

12/12 — Rupture of 6 inch steam line. M18.

ROBINSON 2

04/13 — Ultrasonic testing of reactor vessel showed signs of cracking. M6.

04/23 — Broken reactor coolant pump bolts, probably due to stress corrosion cracking. LER-261-82-003, P4.

08/20 — Steam generator power-operated relief valve opened due to broken linkage and then stuck open. M12.

12/20 — Reactor trip circuit breaker fails during testing. P7.

ST. LUCIE 1

04/24 — Failed gasket leads to excessive leakage from reactor coolant system. LER-335-82-014, M7.

09/02 — Generator trip relay shorted and caused reactor shutdown. LER-335-82-040, M12.

09/07 — Reactor shutdown led to loss of vital power supply. LER-335-82-041, M12.

SALEM 1

02/01 — 23,000 gallons of radioactive water from spent fuel pool dumped into auxiliary buildings, spilling contamination on 16 workers. LER-272-82-010, M2, P3.

03/16 — Loss of all component cooling water and service water flows. LER-272-82-015, E.

05/02 — Failed circuit caused spurious actuation of emergency equipment. LER-272-82-031, E.

08/16 — Notification by Westinghouse of needed modifications to avoid problems with Solid State Protection System. Salem management decided there was no need to make changes.

LER-272-82-064, E.

10/00 — Manway leakage from 3 of 4 steam generators. M16.

10/17 — Inoperable containment atmosphere sensing system. LER-272-82-078. N83-23.

SALEM 2

01/10 — Steam generator pressure instruments fail because of frozen sensing lines. LER-311-82-001. M1.

01/14 — Steam generator safety relief valve stuck open, control rods fail to respond to manual control. LER-311-82-004, M1, E.

04/18 — Control rod position indicator inoperable. LER-311-82-026, E.

05/03 — Service water leakage from containment fan coil unit. LER-311-82-028, E.

05/03 — Low service water flow to containment fan coil unit. LER-311-82-038, E.

05/19 — Leakage from piping to containment fan coil unit. LER-311-82-040, E.

05/26 — 100 gallon/minute service water leak from containment fan coil unit motor cooler due to failed weld. LER-311-82-039, E.

08/20 — Reactor trip breaker failed to work because of failure of undervoltage trip mechanism. LER-311-82-72, M12.

08/21 — Containment fan coil unit leak. LER-311-82-080. M12.

09/08 — Containment fan coil unit leak. LER-311-82-092, M12.

SAN ONOFRE 1

01/12 — Improper design led to potentially incorrect circuit indication. LER-206-82-001, E.

05/10 — Five broken support bars and other debris found loose inside steam generator. M8, N83-24.

05/13 — Flooding of pump bay led to the total loss of all salt water cooling capability for 24 minutes. LER-206-82-015, M8, P4, A2.

08/13 — Operator error damages south salt water cooling pump. LER-206-82-024, A2.

08/19 — North salt water cooling pump damaged by leakage of salt water into bearings. LER-206-82-022, M2, A2.

SAN ONOFRE 2

03/14 — Loss of shutdown cooling system. LER-361-82-002, M5, P3.

03/16 — Boron stratification in the refueling water storage tank due to lack of recirculation. LER-361-82-006, M5, P3.

04/28 — Plant shut down because operators thought reactor coolant system was leaking excessively. Leak testing failed to account for leaks elsewhere in system. LER-361-82-013, M7.

05/28 — Excessive noise and vibration in main feedwater line. M9.

11/09 — Operator accidentally dislodged power cord, cutting power to feedwater control system. Reactor was manually tripped, and emergency core cooling system came on, dropping temperature of reactor coolant system faster than operating license allows. LER-361-82-136, M17, P7.

SAN ONOFRE 3

12/17 — Inadvertent actuation of engineered safety features damages all high pressure safety injection pumps. LER-362-82-006, M19.

SEQUOYAH 1

01/19 — Explosion of neutral grounding transformer caused by short in main transformer. Automatic fire system did not activate although fire lasted thirty minutes. M1.

06/18 — Containment sump level instrument found likely to rupture during a loss of coolant accident, preventing use of containment sump suction for emergency core cooling system. LER-327-82-070, M11.

09/14 — Reactor coolant pump seal failure caused a 70-80 gallon/minute leak. M13.

11/05 — Check valve failed, and part of it came loose, lodging downstream in steam dump header. LER-327-82-126, M17.

SEQUOYAH 2

04/26 — Ice condenser deck doors froze shut because drain pan of air handling unit was improperly installed. LER-328-82-52, E.

SURRY 1

01/12 — Fire hydrants inoperable because of frozen water. LER-280-82-004, P5.

04/18 — Relief valve prematurely lifted, causing unplanned release of radiation. LER-280-82-047, E.

06/20 — Safety injection accumulators inoperable. LER-280-82-072, E.

09/01 — Service water pump lost suction pressure. LER-280-82-087, E.

SURRY 2

09/01 — Service water pump lost suction pressure. LER-281-82-057, P6, E.

09/14 — Service water pump lost suction pressure. LER-281-82-053. P6.

SUSQUEHANNA 1

00/00 — Swing check valve problems. N82-20.

TMI-2

01/15 — Leak from borated water storage tank line. M1.

TROJAN

01/12 — Spurious safety injection while switching power supplies. LER-344-82-000S, M1.

03/02 — Operator error made containment spray pump and charging pump unavailable. P6.

04/26 — Fuel assemblies had abnormal cladding degradation due to vibration of fuel rods. LER-344-82-006, P3, N82-27, E.

06/08 — Several sheets of metal from thermal sleeving of safety injection system and several fuel pellets were found in reactor vessel. LER-344-82-011, M9, N82-30, E.

08/20 — Licensed operator error made automatic actuation of the emergency core cooling system unavailable for period of 43 hours. LER-344-82-015, P6, E.

08/24 — Licensed operator error made residual heat removal system unavailable for 5 hours. P6.

10/03 — Due to overly high voltage, lamp socket broke and fell into control panel, causing short circuit. Fuse blew, and power to start emergency diesel generator was lost. N83-08.

TURKEY POINT 3

04/29 — Blackout of 700,000 customers. Condensate pump malfunction led to loss of feedwater and reactor trip. Emergency diesel generators started, which cut power to non-vital loads including Unit 4 control rod position indication panel, which tripped that reactor also. M7.

05/15 — Accidental partial insertion of control rods led to reactor trip. M8.

05/20 — Power lost to control rod drive, causing all control rods to insert. M8.

TURKEY POINT 4

04/29 — Trip in Unit 3 caused shedding of non-vital loads which caused power loss to Unit 4 control rod position indication panel, resulting in a reactor trip. Grid perturbation tripped two fossil units as well, causing 20 to 50 minute blackout of 700,000 customers. M7.

07/12 — Steam generator tube leak due to foreign objects, including pieces of metal, valve pins, wire and rods. LER-251-82-010. M11. N83-24.

09/06 — Pressurizer spray valve stuck open, causing rapid depressurization of reactor coolant system and actuation of high pressure coolant injection system. LER-251-82-013, M12.

VERMONT YANKEE

04/24 — Reactor scram, automatic start of diesel generator and high pressure injection. Actuation of emergency core cooling system was not noticed by operators for two hours. M7, P5.

05/13 — Degraded power supply caused anomalous low water level readings from reactor vessel sensors. N83-04.

05/19 — Lightning makes process computer and certain alarms inoperable. M8.

YANKEE ROWE

11/16 — Release of radioactivity from valve in waste gas system inadvertently left open for 58 hours. P7.

ZION 1

02/25 — Two 30-inch steel hinges and 36 nut-bolt-washer assemblies found in primary coolant side of steam generator. About 1100 protuding tube ends were damaged, and extensive repairs were necessary. Hinges were thought to be part of an aluminum tube nozzle cover that had dissolved. Loose parts signal alarm had sounded but was ignored. M3, P2, N83-24.

03/25 — Shift engineer received whole-body exposure of five rems when he entered reactor cavity which had not been surveyed for radiation. LER-295-82-014, P4, N82-51.

09/30 — Control rod drive failure led to reactor trip. M15, P6.

10/25 — Unplanned release of radiation due to leakage from waste gas system. P7.

ZION 2

01/09 — Steam generator pressure channel failed because of frozen sensing line. LER-304-82-001, P5.

03/15 — Reactor trip relay burned up because it was not made for voltage as high as specified in plant design. LER-304-82-004, N83-08.

08/27 — Two auxiliary feedwater pumps inoperable. LER-304-82-021, M12.

10/06 — Control rod drive coils found defective. Possibly caused by steam or boric acid from primary coolant leak in 1981. P6.

10/25 — Unplanned release of radiation. P7.

Emergency Planning Statistics

Plant Site	State	Population (Cumulative Totals: 0-10 and 0-50)					
		0-10 mi	10-20 mi	20-30 mi	30-40 mi	40-50 mi	0-50 mi
Arkansas	[illegible]	25,000	32,237	29,250	32,6[illegible]1	66,622	185,720
Beaver Valley	PA	137,000	331,498	1,116,350	1,190,857	809,691	3,585,396
Bellefonte	AL	28,000	42,004	76,985	324,341	462,439	933,769
Big Rock Point	MI	9,700	29,532	18,043	42,779	62,017	162,071
Braidwood	IL	31,000	95,949	332,294	1,027,704	2,773,799	4,250,746
Browns Ferry	AL	28,000	102,727	158,010	287,700	129,132	705,569
Brunswick	NC	11,000	71,142	56,124	30,071	52,279	220,616
Byron	IL	21,000	227,448	217,990	165,114	310,107	941,659
Callaway	MO	7,600	34,324	92,247	132,712	89,218	356,101
Calvert Cliffs	MD	20,000	74,659	116,877	462,080	1,913,857	2,587,473
Catawba	SC	74,000	433,470	302,972	285,054	313,466	1,408,962
Clinton	IL	14,000	38,307	274,333	192,057	237,035	755,732
Comanche Peak	TX	15,000	17,099	66,698	345,547	480,107	924,451
DC Cook	MI	54,000	126,249	346,899	210,936	382,640	1,120,724
Cooper Station	NB	5,700	17,.053	33,547	43,776	78,115	178,191
Crystal River	FL	14,000	30,370	31,926	129,188	191,258	396,742
Davis-Besse	OH	15,000	84,918	584,077	373,119	772,905	1,830,019
Diablo Canyon	CA	18,000	82,791	72,500	58,360	38,445	270,096
Dresden	IL	39,000	231,781	627,198	1,824,557	3,749,569	6,472,105
Duane Arnold	IA	79,000	98,271	62,869	176,653	159,504	576,297
Farley	AL	7,600	80,305	49,514	92,716	105,929	336,064
Fermi	MI	74,000	318,788	1,605,051	1,950,455	1,078,787	5,027,081
Fitzpatrick	NY	42,000	60,116	137,977	413,576	213,353	867,022
Fort Calhoun	NB	14,000	293,294	319,716	66,698	53,088	746,796
Fort St. Vrain	CO	11,000	211,847	437,542	816,795	385,159	1,862,343
Ginna	NY	39,000	526,437	243,267	155,163	219,287	1,183,154
Grand Gulf	MS	10,000	22,177	66,956	84,208	141,481	324,822
Haddam Neck	CT	74,000	486,871	1,231,756	635,711	1,021,779	3,450,117
Hatch	GA	5,300	43,538	56,495	50,416	140,297	295,046
Hope Creek	NJ	25,000	[illegible]38,427	572,971	1,722,036	2,053,140	4,771,574
Indian Point	NY	240,000	734,157	3,004,196	5,745,383	5,644,900	15,368,636
Kewaunee	WI	11,000	68,450	172,552	103,634	255,171	610,807
La Crosse	WI	6,600	84,448	65,686	89,459	98,245	344,438
LaSalle	IL	15,000	80,999	185,680	305,787	576,500	1,163,966
Limerick	PA	164,000	672,964	2,733,336	2,071,822	1,229,507	6,871,629
Maine Yankee	ME	30,000	60,480	154,690	200,195	104,773	550,138
Marble Hill	IN	21,000	84,352	435,135	549,168	269,435	1,359,090
McGuire	NC	46,000	502,111	378,781	366,088	305,763	1,598,743
Midland	MI	75,000	271,995	158,037	133,630	444,841	1,083,503
Millstone	CT	114,000	165,040	187,514	748,269	1,348,231	2,563,054
Monticello	MN	24,000	73,921	305,435	874,044	855,832	2,133,232
Nine Mile Point	NY	42,000	64,367	130,023	405,106	217,845	859,941
North Anna	VA	11,000	50,640	110,786	429,614	449,194	1,051,234
Oconee	SC	51,000	82,766	293,253	252,730	237,184	916,933
Oyster Creek	NJ	71,000	227,634	287,487	771,253	2,136,878	3,494,252
Palisades	MI	34,000	82,794	120,105	353,426	522,802	1,113,127
Palo Verde	AZ	2,100	9,259	11,781	189,917	695,125	908,182
Peach Bottom	PA	29,000	274,530	700,282	1,811,174	1,576,189	4,391,175
Perry	OH	74,000	183,424	435,255	841,173	884,296	2,418,148
Pilgrim	MA	41,000	170,759	698,797	1,308,929	2,033,485	4,252,970
Point Beach	WI	21,000	59,963	130,553	194,470	201,566	607,552
Prairie Island	MN	23,000	65,291	230,108	1,011,059	808,815	2,138,273
Quad Cities	IL	54,000	261,222	160,983	113,982	129,062	719,249
Rancho Seco	CA	12,000	184,446	944,319	216,562	471,618	1,828,945
Robinson	SC	27,000	49,580	148,514	179,748	263,622	668,464
Salem	NJ	25,000	380,110	580,970	1,692,136	2,068,780	4,746,996
San Onofre	CA	49,000	286,301	481,212	1,474,780	2,531,643	4,822,936
St. Lucie	FL	88,000	65,892	67,868	90,875	217,557	530,192
Seabrook	NH	90,000	248,069	717,427	1,335,721	1,275,990	3,667,207
Sequoyah	TN	39,000	317,081	136,093	167,480	137,686	797,340
Shearon Harris	NC	20,000	191,416	400,978	342,264	337,732	1,292,390
Shoreham	NY	98,000	491,116	1,288,231	1,200,761	2,159,348	5,237,456
South Texas	TX	2,700	30,193	19,521	82,199	90,360	224,973
Summer	SC	8,900	76,[illegible]70	336,870	147,047	255,150	824,537
Surry	VA	73,000	193,203	306,827	624,975	502,555	1,700,560
Susquehanna	PA	52,000	301,198	279,820	397,121	557,551	1,587,690
Three Mile Island	PA	162,000	515,823	446,054	273,558	710,209	2,107,644
Trojan	OR	65,000	53,287	117,262	613,060	511,062	1,359,671
Turkey Point	FL	58,000	300,202	788,813	574,613	473,577	2,195,205
Vermont Yankee	VT	32,000	95,828	120,829	316,594	787,210	1,352,461
Vogtle	GA	2,200	28,111	275,915	114,204	108,052	528,482
Waterford	LA	56,000	310,759	832,162	309,605	325,297	1,833,823
Watts Bar	TN	16,000	66,862	144,498	176,961	435,[illegible]07	843,528
WPPSS 1	WA	1,700	91,662	62,002	43,197	59,853	258,414
WPPSS 2	WA	1,700	92,648	56,929	48,182	58,544	258,003
WPPSS 3	WA	11,000	45,591	112,689	87,592	213,025	469,897
Wolf Creek	KS	5,500	10,686	47,187	52,128	57,968	173,469
Yankee Rowe	MA	25,000	92,040	158,081	396,495	868,482	1,540,098
Zimmer	OH	28,000	222,912	910,091	403,271	343,003	1,907,277
Zion	IL	249,000	356,234	917,098	2,739,550	2,815,293	7,077,175

NRC "Worst-Case" Estimates			Emergency Plan Status		Evacuation Time Estimates	
Early Deaths	Cancer Deaths	Costs Billion Dollars	State Plan(s)	County Plan(s)	Normal	Ab-normal
2,100	3,000	84.9	A	A	—	3.0
19,000	24,000	122.0	D	D	5.8	7.3
3,600	4,500	86.1	D	D	—	—
120	450	13.2	A	A	1.6	1.3
6,750	14,200	127.0	D	D	—	—
18,000	3,800	73.0	A	B	10.0	14.0
7,500	4,600	56.5	A (1/2)	A	—	—
9,050	15,300	114.0	C (1/2)	C	—	—
11,500	9,600	110.0	C	C	—	—
5,600	23,000	92.0	C	C	9.1	18.3
42,000	5,800	101.0	D	D	—	—
1,600	13,000	92.8	D	D	—	—
1,200	4,800	117.0	C	C	—	—
2,000	13,000	101.0	B (1/3)	B	5.9	7.6
1,600	3,100	57.2	B (2/3)	B	1.1	—
900	2,800	53.8	D	D	3.0	6.0
1,400	10,000	84.0	B (1/2)	B (1/2)	3.5	7.0
10,000	12,000	158.0	D	D	4.3	5.0
42,000	13,000	89.6	A (1/2)	A	[illegible]	—
2,900	7,000	53.8	C	C	10.6	10.9
12,000	2,900	59.1	A (2/3)	A	6.0	8.0
8,000	13,000	136.0	C (1/2)	C (2/3)	—	—
1,000	17,000	103.0	B	B	3.8	5.7
3,000	3,000	43.5	C	C	4.2	—
3,000	1,000	38.8	A	A	10.0	—
2,000	14,000	63.0	B	B	5.2	6.4
4,500	3,800	83.0	A	A	—	—
29,000	23,000	74.1	—	—	8.3	9.9
700	3,000	56.0	C	C	10.0	12.0
—	—	—	D	D	—	—
50,000	14,000	314.0	B (1/3)	B	5.2	7.5
900	8,000	46.9	C	C	4.0	—
70	200	16.0	B (2/3)	B (2/3)	2.0	4.0
14,000	15,000	120.0	A (1/2)	A	—	—
74,000	34,000	213.0	D	D	—	—
8,000	21,000	78.5	B (1/2)	B	3.8	7.4
12,000	8,000	87.2	D	D	—	—
12,000	26,000	110.0	A (1/2)	A	1.4	1.7
7,000	10,000	80.4	D	D	—	—
23,000	38,000	174.0	C (1/3)	C	9.6	11.1
500	4,000	44.6	B	B	1.5	2.0
1,400	20,000	134.0	C	C	3.8	5.7
1,400	20,000	66.0	A (1/2)	A	3.8	16.0
4,000	4,000	58.3	A (1/3)	A	3.5	4.5
13,000	23,000	79.8	B (1/3)	B	6.0	9.0
1,000	10,000	52.6	A (1/2)	A	2.6	2.8
4,000	15,000	89.7	B	B	—	—
72,000	37,000	119.0	B (2/4)	B	3.0	9.0
5,500	14,000	102.0	D	D	—	—
3,000	23,000	81.8	B (1/2)	B	7.3	5.2
500	7,000	43.8	C	C	4.0	8.0
2,000	4,000	49.5	C	C	1.8	2.3
12,000	12,000	65.1	B	B	12.0	—
30,000	6,000	113.0	D	D	3.7	4.4
2,000	3,000	42.5	A (1/2)	A	—	—
100,000	40,000	150.0	B (1/4)	B (10/12)	6.0	—
27,000	18,000	186.0	B	B	5.0	2.7
5,000	3,000	59.1	D	D	6.3	9.0
7,000	6,000	163.0	D	D	—	—
29,000	4,700	98.6	A (1/3)	B	2.2	6.6
11,000	6,000	68.5			—	—
40,000	35,000	157.0	D	D	—	—
18,000	4,000	112.0	D	D	—	—
5,000	4,000	68.2	A	A	—	—
31,000	23,000	57.8	A (1/2)	A	10.0	13.0
67,000	28,000	143.0	B	B	—	—
46,000	28,000	122.0	C	C	13.0	27.0
1,000	5,000	89.7	A	A	6.0	6.6
29,000	4,000	48.6	D	D	6.1	6.4
7,000	17,000	68.8	C	C	1.1	1.8
200	4,000	70.3	D	D	—	—
96,000	9,000	131.0	C	C	—	—
5,000	4,000	86.6	D	D	—	—
200	4,000	80.4	D	D	—	—
300	4,000	77.3	D	D	—	—
173	4,000	73.7	D	D	—	—
1,000	3,000	105	D	D	—	—
1,000	4,000	21.4	B (2/5)	B	0.9	1.8
9,000	10,000	84.5	D	D	—	—
14,000	17,000	146.0	C (1/2)	C (1/2)	1.0	—

Emergency Planning

Until the Three Mile Island accident, the mindset of the NRC, as documented by the President's Commission on the Accident at TMI ("the Kemeny Commission"), was that serious accidents would not happen. But in late 1979, shaken awake by TMI, the NRC proposed new rules that would require the adoption of emergency plans around nuclear plants. The NRC said: "The accident showed clearly that the protection provided by siting and engineered safety features must be bolstered by the utility to take protective measures during the course of an accident." Under the new rules, emergency planning and preparedness would be considered "as equivalent to, rather than as secondary to, siting and design in public protection." [44 F.R. 75167, 75169 (December 19, 1979).]

In due course, the new rules were adopted. Utilities were required to draft on-site and off-site emergency plans for review by the local government, the state and the Federal Emergency Management Agency (FEMA), with final approval from the NRC after testing the plan. The NRC had to find "that the state of on-site and off-site emergency preparedness provides reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency." The new rules would either force utilities to prepare for emergencies or shut them down until they would.

But it has not worked that way in practice. As Three Mile Island recedes into memory, so has the NRC's interest in emergency planning rules. The agency repeatedly failed to enforce its own deadlines for installation of warning sirens within the 10 mile evacuation zone. And recently the NRC allowed the Indian Point plant to continue operation in spite of repeated conclusions by FEMA that Indian Point's emergency plan is inadequate.

Only thirty miles from New York City, Indian Point has almost a quarter of a million people living within ten miles of the plant, and more than 15 million within 50 miles. Three years after the NRC promulgated its rules on emergency planning, and two years after all plants were to have complied with those requirements, Indian Point still

Population figures are from unpublished NRC data based upon the 1980 census. **Early deaths** are radiation-induced non-cancer deaths within one year of the accident. Figures assume state-of-the-art medical help is available. If only normal hospital treatment is available, these figures may be understated by a factor of 3 or 4. **Cancer Deaths** are counted over the lifetime of the exposed population, except for leukemia deaths more than 30 years after the accident. **Cost** includes lost wages, relocation expenses, decontamination expenses and lost property, but not health-care costs, on-site costs, litigation costs and certain other costs. **Emergency Plan Status** is from FEMA's July 1983 report to Congress. The status of state and county off-site emergency planning is listed as **A** (Formal approval of emergency plan by FEMA), **B** (Joint Exercise has been held to test plan), **C** (Plan has been submitted to FEMA), or **D** (Plan has not yet been submitted to FEMA). Where the 50-mile emergency planning zone reaches multiple states or counties, the numbers in parentheses indicate if some but not all plans have progressed as far as the letter code indicates. **Evacuation time**, estimated in hours, is from "An Analysis of [ten mile] Evacuation Times Around 52 Nuclear Power Plant Sites," NUREG/CR-1856, Vo. 2 (1981) and are given for normal and adverse weather conditions. Shorter adverse times reflect lower population density during adverse weather seasons.

does not meet the minimum requirements. In April 1983, FEMA rejected the Indian Point emergency plan, telling the NRC that it "cannot assure that the public health and safety can be protected in the 10-mile emergency planning zone (EPZ) around Indian Point."

The NRC has already given the utilities (Consolidated Edison runs Unit 2, and Unit 3 is run by the Power Authority of the State of New York) plenty of time — it set a 120-day deadline for developing a workable plan, then failed to enforce it. Then it set another 120-day deadline, and failed to enforce that deadline either. Following FEMA's rejection the NRC gave the utilities still more time to solve the plan's deficiencies, threatening to shut the plants down unless they met the minimum standards by June 9, 1983.

NRC Commissioner John Ahearne said "people are watching to see if we stand behind our regulations. If we do not, I expect emergency planning will deteriorate nationwide."

But when the deadline came, Ahearne backed down, and so did the majority of the five Commissioners. Even though FEMA still found the plan inadequate, the NRC once again failed to enforce its own rules. NRC Chairman Nunzio Palladino explained it by saying that the utilities had made the "commitment" to resolving the flaws in the emergency plan, and added that shutting down the plants would cost money.

Commissioner James Asselstine dissented, saying, "This makes a mockery of our emergency planning regulations."

The failure of the NRC to enforce its own rules took on added significance in 1982 following the release of a study done for the NRC by the Department of Energy's Sandia National Labs. It showed that "worst-case" accidents at nuclear power plants could cause as many as 100,000 early deaths and $300 billion worth of damage. The NRC's previous estimates, in the controversial "Rasmussen report" of 1975, were that a worst-case accident could cause 3,300 early deaths and $14 billion in damage. Fortunately, these "worst-case" accidents are not very likely. The NRC assumes that the likelihood of a severe reactor accident is one in 100,000 per reactor-year, and factoring in the worst conceivable weather conditions would lower the probability of the worst-case accident still further.

But even with good weather, a severe reactor accident would be catastrophic. And, in fact, the NRC's estimates of the chances of a severe accident may be greatly understated. The NRC's Advisory Committee on Reactor Safeguards (ACRS), which acts as the agency's technical conscience, has noted that there is "general agreement that large uncertainties exist in our ability to predict both the probabilities and the consequences of severe accidents." This is true for many reasons. One is that in spite of a 25-year history of reactor accidents, there have not been enough really severe accidents to be able to reliably calculate theie likelihood. Another problem is that although one can test a machine to see how soon it breaks, there is no adequate model to calculate the likelihood of human error. And the NRC freely admits that it doesn't even try to calculate the probability of sabotage.

Although the NRC is losing its interest in emergency planning, the dangers have not gone away. The table on the preceeding two pages shows how great the human suffering and cost could be for people living near a nuclear plant, if their luck runs out.

Unresolved Safety Issues	Date Designated
Water Hammer	1978
Asymmetric Blowdown Tube Integrity	1978
Westinghouse Steam Generator Integrity	1978
Combustion Engineering Steam Generator Integrity	1978
B&W Steam Generator Integrity	1978
*Mark I Short Term Program	1978
Mark I Long Term Program	1978
*Mark II Containment Pool Dynamic Loads	1978
Anticipated Transient Without Scram	1978
BWR Feedwater Nozzel Cracking	1978
Reactor Vessel Materials Toughness	1978
Steam Generator and Coolant Pump Supports	1978
Systems Interaction	1978
Qualifications of Electrical Equipment	1978
Reactor Vessel Pressure Transient Protection	1978
Residual Heat Removal Requirements	1978
Control of Heavy Water Loads Near Spent Fuel	1978
*Safety Relief Valve Pool Dynamic Loads	1978
Seismic Design Criteria	1978
Pipe Cracks in Boiling Water Reactors	1978
Containment Emergency Sump	1978
Station Blackout	1978
Shutdown Decay Heat Removal Requirements	1981
Seismic Qualification of Equipment	1981
Safety Implications for Control Systems	1981
Hydrogen Control and Burns	1981
Pressurized Thermal Shock	1982

* Completed
Source: Unresolved Safety Issues Summary, NUREG-0606.

Generic Safety Issues with "High Priority" Rankings (Includes TMI Action Plan Items)

Reactor Coolant Pump Seal Failures
Bolting Degradation or Failure
Adequacy of Safety-Related DC Power Supplies
Loads, Load Combinations, Stress Limits
Behavior of BWR Mark III Containments
Diesel Reliability
Main Steam Line Leakage Control Systems
Training and Qualifications of Operating Personnel
Revise Regulatory Guide 1.8
Requirements for Operator Fitness
Research on Training Simulators
Review Simulators for Conformance to Criteria
Expand Quality Assurance List
Behavior of Severely Damaged Fuel
Behavior of Core Melt
Risk Reduction for Operating Reactors at Sites with High Population Densities
Rulemaking Proceeding on Degraded Core Accidents
Interim Reliability (Engineering) Evaluation Program
Continuation of Interim Reliability (Engineering) Evaluation Program
Reliability Engineering
Containment Integrity Check
Examine TMI-2 Containment Structure
Radiation Protection Plans
Assess Safety Decision Making for Currently Operating Reactors

Source: A Prioritization of Generic Issues, NUREG-0933 (1983).

Generic Safety Problems

Among the most ominous dangers of nuclear power are those that arise from the designs of the plants themselves. Such problems are referred to as generic issues, and extend to all similarly designed reactors. Generic problems have been considered particularly serious both by the government and nuclear critics, because in an accident, even if plant equipment and operators do their jobs as they are supposed to, faulty plant design could result in a dangerous accident.

The NRC continues to identify generic deficiencies but is slow to find solutions to the problems they pose. At present, more than 300 of these safety design flaws are unsolved. A group of 27, designated as "Unresolved Safety Issues," are considered by the NRC to be the most important safety problems. These Unresolved Safety Issues are defined by the NRC as problems for which no final resolution has been developed and that involve conditions not likely to be acceptable over the lifetime of the affected plants. Yet resolutions have been fully implemented for only three. The Unresolved Safety Issues are listed below.

In addition to official Unresolved Safety Issues, many other serious generic issues still exist. After the accident at Three Mile Island, intense investigations by Congress, a special presidential commission and the NRC itself revealed that the agency had largely ignored many aspects of nuclear power plant operation with crucial impact on plant safety. In response, the NRC developed the "TMI Action Plan," a program aimed at resolving 347 specific safety issues. These were divided into four broad areas: operational safety, including operator training and redesign of the control room to make it less confusing to operators; siting and design; emergency preparedness, including improved communication during emergencies and devising evacuation plans; and practices and procedures.

The NRC began to implement the Action Plan about a year after the TMI accident, but even now, more than four years after the accident, only 55 percent of the items have been completed. And of the 155 items remaining, almost half are "priority one" items.

The list of safety problems goes on. There are now 67 new "generic issues" defined by the NRC after the TMI Action Plan items were identified. And finally, there are scores of other generic problems that have fallen through the cracks. According to one NRC official, "Engineers are not interested in the seemingly small problems. They tend to shy away from (them)." These problems have been placed into different categories and programs.

In March, 1983, the NRC issued a report on generic issues not covered in the TMI Action Plan or as Unresolved Safety Issues. Issues were placed into one of four rankings: high, medium, low and drop. Assignment of a high priority meant that, "strong efforts to achieve an earliest practical resolution are appropriate because an important safety deficiency is involved." In most instances, a cost-benefit analysis was done that balanced safety considerations against the cost of developing and implementing solutions.

The number of serious problems identified by these various programs (Unresolved Safety Issues, the TMI Action Plan, and the Prioritization of Generic Issues) is staggering. For example, 122 items have been labeled either as "priority one," "high priority," or as an Unresolved Safety Issue because they all have the potential to cause serious accidents at nuclear power plants. But the NRC is well-known for foot dragging on tough safety issues. The backlog, lack of staff and resources, and lack of commitment to finding solutions delay the resolution process while the health and safety of the public is compromised by the continued operation of unsafe plants.

A few of the most important unresolved problems are the following:

Steam Generator Tube Integrity (Unresolved Safety Issue)

The accident at the Robert E. Ginna plant in upstate New York in early 1982 has dramatized the problem of steam generator tube integrity (see p.3). A steam generator is like a radiator, with thousands of small tubes that carry the highly pressurized cooling water that has passed through the reactor core, circulating it through a second flow of cooling water that boils to form the steam that makes electricity. Ruptures and leaks in these tubes can be caused by any number of things, from foreign objects left inside the steam generator to corrosion. Steam generator tube ruptures are serious, and can even lead to a meltdown. If a number of tubes rupture at once, cooling water will be drained from the reactor core. If steam builds up in the reactor vessel, it could prevent water from the Emergency Core Cooling System (ECCS) from effectively removing the heat of the reaction, thereby causing the core to melt.

Ginna was only the latest in a series of dramatic tube ruptures. The table below shows the history of major tube ruptures in the United States. According to the probabilistic calculations of the NRC, such accidents were supposed to happen only once every 40 years, instead of once every year or two.

MAJOR STEAM GENERATOR TUBE RUPTURES IN THE UNITED STATES

Plant	State	Date of Event	Maximum Leak Rate
Point Beach 1	WI	February 26, 1975	125 Gallons/minute
Surry 2	VA	September 15, 1976	330 Gallons/minute
Prairie Island	MN	October 2, 1979	336 Gallons/minute
Ginna	NY	January 25, 1982	760 Gallons/minute

Source: "Evaluation of Steam Generator Tube Rupture Events," NUREG-0651 (1980); "NRC Report on the January 25, 1982 Steam Generator Tube Rupture at R.E. Ginna Nuclear Power Plant," NUREG-0909 (1982).

Plants with Steam Generator Problems

Plant	Vendor	Steam Generators	Problems in 1982
Arkansas 1 (AR)	BW	2	TL
Arkansas 2 (AR)	CE	2	TL
Beaver Valley 1 (PA)	W	3	TL
Calvert Cliffs 1 (MD)	CE	2	TL
Calvert Cliffs 2 (MD)	CE	2	
Connecticut Yankee (CT)	W	4	
Cook 1 (MI)	W	4	FO, OT
Cook 2 (MI)	W	2	TL, OT
Crystal River (FL)	BW	2	
Davis-Besse (OH)	BW	2	
Farley 1 (AL)	W	3	
Fort St. Vrain (CO)*	CE	2	TL
Ginna (NY)	W	2	TR, TL
Indian Point 2 (NY)	W	4	
Indian Point 3 (NY)	W	4	TL
Kewaunee (WI)	W	2	
Maine Yankee (ME)	CE	3	PT, OT
McGuire (NC)	W	4	FO
Millstone 2 (CT)	CE	2	
North Anna 1 (VA)	W	3	FO
North Anna 2 (VA)	W	3	
Oconee 1 (SC)	BW	2	TL
Oconee 2 (SC)	BW	2	
Oconee 3 (SC)	BW	2	TL
Palisades (MI)	CE	2	TL
Point Beach 1 (WI)	W	2	TL, PT, FO
Point Beach 2 (WI)	W	2	PT, FO
Prairie Island 1 (MN)	W	2	
Prairie Island 2 (MN)	W	2	
Rancho Seco (CA)	BW	2	TL
Robinson 2 (SC)	W	3	TL, PT
Salem 1 (NJ)	W	4	PT, OT
San Onofre 1 (CA)	W	3	TL, FO
St. Lucie 1 (FL)	CE	2	
Sequoyah 1 (TN)	W	3	
Surry 1 (VA)	W	3	
Surry 2 (VA)	W	2	
Three Mile Island 1 (PA)	BW	2	
Three Mile Island 2 (PA)	BW	2	
Trojan (OR)	W	4	
Turkey Point 3 (FL)	W	3	
Turkey Point 4 (FL)	W	3	TL, FO
Yankee Rowe (MA)	W	4	TL, PT
Zion 1 (IL)	W	4	PT, FO
Zion 2 (IL)	W	4	

Source: NRC Licensee Event Reports; "Steam Generator Experience and Requirements," NRC briefing paper, 1/18/82; Atomic Industrial Forum.

Vendor: BW — Babcock & Wilcox; CE — Combustion Engineering; W — Westinghouse

Problem: TR — Tube rupture; TL — Tube leak; PT — Tube had to be plugged; FO — Foreign object; OT — Other steam generator problems in 1982.

* Fort St. Vrain is a High Temperature Gas Cooled Reactor rather than a Pressurized Water Reactor. Its steam generators have also had problems.

Dramatic ruptures are not the only steam generator problem. Even more common than tube ruptures are tube leaks, denting and corrosive attack. In fact, fully 45 of the 49 pressurized water reactors in the U.S. have had steam generator problems at some point during their life, as shown in the table to the left.

This continuing problem was evident in 1982 as well. As can be seen in the table to the left, 16 plants other than Ginna had to shut down because of leaking steam generator tubes. And in an effort to prevent damaged tubes from leaking, seven plants permanently plugged some of their tubes in 1982 to stop the flow of water completely.

The Ginna accident was caused by a foreign object damaging the delicate tubes in the steam generator. In 1982, eight other plants discovered debris of various sorts in their steam generators. At Point Beach 1 (WI) a large "C" clamp was discovered in the steam generator. And at Turkey Point 4 (FL), an NRC staffer quoted the utility as saying that it had "a bucket of parts" in its steam generator.

Other plants had still other steam generator problems. For example, at the Salem 1 plant in New Jersey, water had actually leaked out of the steam generator, through the "manway" (a human entrance to a steam generator), and at Cook 1 (IL) a leaking safety valve was found. A leaking safety valve played a big part in the release of radiation at Ginna.

There has been no resolution to the tube leak problems of steam generators. There are "band-aid" measures of plugging or "sleeving" individual tubes, but eventually the steam generators have to be replaced, at huge costs both in terms of radiation exposure to workers and financial costs, which utilities try to pass on to their ratepayers. At Turkey Point 3 and 4 in Florida, steam generator replacement exposed workers to 2,184 person-rems and cost an estimated $190 million in capital costs and $422 million for replacement power while the plants were shut down.

Ralph Nader has aptly called steam generators "the single biggest product failure in the annals of American business."

For a discussion of the Ginna accident, see page 3. For a general discussion of steam generators, see *Tube Leaks: A Consumer's and Worker's Guide to Steam Generator Problems at Nuclear Power Plants*, available from Public Citizen.

Pipe Cracks in Boiling Water Reactors (Unresolved Safety Issue)

In boiling water reactors (BWRs), boiling water circulates through the reactor core, carrying away heat in the form of steam. Since 1960, the pipes in these BWRs have experienced cracking, which could lead to a major loss of coolant accident and a core melt. In 1978, the NRC designated this problem as an Unresolved Safety Issue. Since that time, the problem has grown. In 1982, at the Nine Mile Point reactor in Oswego, New York, cracking was discovered that was so severe that the NRC ordered

inspections for all BWRs. Large cracks have been found at Peach Bottom 2 and 3 in Lancaster, Pennsylvania, and Hatch 1 and 2 in Baxley, Georgia. Because the staff found cracking at the vast majority of reactors it inspected, the NRC decided to immediately shut down and inspect the 5 BWRs not yet inspected. The nuclear industry responded with tremendous pressure on the NRC, which reversed its decision the next day, agreeing to wait to inspect the plants until industry studies were done, a delay of months. The NRC Advisory Committee on Reactor Safeguards blasted the NRC for this reversal and strongly objected to the method of inspection the industry was using. That method, which used ultrasonic testing, checks the depth of the cracks in the piping but has proven to be an unreliable measure of the actual severity of the cracks.

The NRC has known for a long time now that these cracks, if ignored, can eventually rupture the pipes. This is crucial because the pipes most often involved in this cracking are the large pipes that recirculate unboiled water back into the reactor. If they ruptured, the reactor core might be unable to retain water, and if that happened the core would overheat and melt.

Pressurized Thermal Shock (Unresolved Safety Issue)

The rapid cooling and increased pressure that occurs when emergency cooling water floods the reactor core is referred to as pressurized thermal shock (PTS). A reactor vessel, typically 40 feet high and 15 feet wide, is made of welded segments of 8-inch steel, and holds the reactor core under enormous pressure. Fissioning uranium in the core bombards the vessel with neutrons. Over time this constant neutron "flux" weakens or "embrittles" the vessel's steel walls. The vessel must be kept at high temperatures in order to be strong enough to withstand the enormous pressure under which the reactor coolant water is kept so it does not boil. If the temperature drops, and pressure remains high, "Pressurized Thermal Shock" could rupture the reactor vessel, causing a meltdown.

Scientists and engineers have known for years that neutron radiation weakens steel, but the embrittlement process is occurring much faster than previously thought possible. Reactor vessels were supposed to last the life of the plant — estimated at 30 to 40 years — but recent studies suggest some vessels have become dangerously brittle in less than 10 years.

The Commission has only recently stepped up its attention to these problems. In late 1981, the NRC formally acknowledged that the containment vessels of 44 of the nation's pressurized water reactors are aging prematurely and may crack under certain conditions. In 1982, Pressurized Thermal Shock was designated as an Unresolved Safety Issue.

The greatest cause of concern is for reactors built before 1973 that have copper in the welds that hold the vessel together. Copper is more easily damaged by neutron bombardment, making these reactors more susceptible to embrittlement. But the most inexorable factor is time — the effect of the neutron flux is cumulative, and so as plants age, the reactor vessels become brittle at higher and higher temperatures, so that a Pressurized Thermal Shock event can happen more easily.

The NRC is studying what can be done about Pressurized Thermal Shock to at least slow down the embrittlement process. Options include replacing the outermost fuel rods with dummies, running the reactor at a lower power output, or, although this has never been tried, "annealing" the entire reactor vessel by heating it to attempt to reverse the embrittlement process.

PLANTS MOST VULNERABLE TO THERMAL SHOCK
(Listed in order of vulnerability)

1.	Robinson 2	8.	Rancho Seco	15.	Arkansas 1
2.	Turkey Point 4	9.	TMI 1	16.	Point Beach 2
3.	Turkey Point 3	10.	Oconee 2	17.	Ginna
4.	Fort Calhoun	11.	Point Beach 1	18.	San Onofre 1
5.	Maine Yankee	12.	Oconee 1	19.	Zion 2
6.	Indian Point 3	13.	Zion 1	20.	Palisades
7.	Yankee Rowe	14.	Indian Point 2	21.	Crystal River 3

Source: Memorandum from William Dircks, NRC Executive Director for Operations, to the Commission, SECY-82-465, November 23, 1982.

Station Blackout (Unresolved Safety Issue)

Safety systems at nuclear power plants depend on a.c. power to operate in emergencies. When a plant shuts down, it turns from using its own power to offsite electricity produced by other power plants. If the switch to offsite power fails, as it often does, then onsite diesel generators can provide emergency power.

Diesel generators, however, are a notoriously unreliable source of emergency back-up power. In an accident, if the diesel generator fails during a loss of offsite power, then the plant would be unable to remove the reactor's heat (which builds up even after the reactor is shut down). Severe core damage could occur and the core could melt. The NRC defined the loss of all power as a station blackout and designated it as an Unresolved Safety Issue in 1977. Both the loss of offsite power and diesel generator failure have frequently occurred independently of one another since that time. It is highly probable that they will eventually occur simultaneously, yet there is still no solution to this potentially lethal problem.

Plants Which Lost Off-Site Power and Emergency Diesel Generator Power in 1982

Brunswick 1	Oyster Creek
Brunswick 2	Pilgrim 1
Calvert Cliffs 1	Quad Cities 1
Calvert Cliffs 2	Quad Cities 2
Grand Gulf	San Onofre
North Anna 2	St. Lucie

Source: NRC Licensee Event Reports.

Plants Which Lost
Emergency Diesel Generator Power in 1982

Arnold	Oyster Creek
Big Rock Point	Palisades
Browns Ferry 1	Pilgrim 1
Browns Ferry 2	Point Beach
Brunswick 1	Prairie Island 2
Brunswick 2	Quad Cities 1
Calvert Cliffs 1	Quad Cities 2
Calvert Cliffs 2	Rancho Seco
Cook	Salem
Crystal River 3	San Onofre
Dresden 2	Sequoyah 1
Dresden 3	Sequoyah 2
Farley 1	St. Lucie
Fitzpatrick	Summer 1
Fort St. Vrain	Surry 1
Grand Gulf	Surry 2
Hatch 2	Susquehanna 1
Kewaunee	TMI 2
LaSalle	Trojan
Maine Yankee	Turkey Point 3
Millstone 1	Vermont Yankee
Millstone 2	Yankee Rowe
Monticello	Zion 2

Source: NRC Licensee Event Reports.

Bolting Degradation or Failure (High Priority Issue)

Nuclear reactors are seamed together with thousands of bolts. In recent years, it has been discovered that many of these bolts are susceptible to corrosion, cracking and leakage at the joints. According to the NRC, failure of bolts could lead to a major loss of coolant accident (LOCA) and release large quantities of radiation:

66 percent of the reported incidents have a direct potential for causing a large break LOCA due to bolting or stud failure in restraints for large piping, component supports, or steam generator manways when these holddown devices have degraded to the point that they will not provide the necessary support following a water hammer or seismic event.

The NRC also notes that degradation of bolts can potentially go undetected until they fail completely. The present inspection program does not require visual inspection, which is the only reliable method to detect degradation.

Containment Emergency Sump (Unresolved Safety Issue)

In a loss of coolant accident (LOCA) in a PWR, water that collects on the floor of the containment flows down through a sump and is recirculated to the core to prevent a core melt. However, testing has shown that debris, such as from piping insulation, will collect in the screens of the sump, not allowing enough water to run the pump, spray nozzels and valves that recirculate the water. Without this water, the uranium fuel could be exposed and melt.

Resolution of these probems is not yet completed and delays in implementation are likely.

Operator Training (TMI Action Plan Item)

The NRC has not only dragged its feet on finding and implementing solutions to technical issues. It has been slow in solving human-factor problems as well. One such example is operator training. The NRC concluded that the chief cause of the TMI accident was the operators' failure to diagnose and respond properly to the unfolding emergency. A series of events similar to those at TMI had happened 18 months earlier at the Davis-Besse plant in Ohio, but the operators managed to avoid a serious accident. Therefore, the Action Plan gave top priority to improving the quality and training of operators.

In December of 1982, however, the General Accounting Office issued a critical report on nuclear power plant operator training. That report, "Problems and Delays Overshadow NRC's Initial Success in Improving Reactor Operators' Capabilities," found that the NRC had made some initial gains in this area by requiring that more personnel be assigned to the control room and making utilities design more rigorous training programs. However, the report concluded that these short-term gains were largely negated by the NRC's delay and pervasive lack of commitment. For example, the NRC delayed for a year and a half before reviewing plans to upgrade training programs. And long-term actions to improve operator training have been hampered by a lack of data, because the NRC failed to do a complete analysis of the specific duties and responsibilities of each key plant position to establish proper standards for training.

The GAO report also criticizes the NRC for failing to commit enough resources to effectively administer the TMI Action Plan. Since the Action Plan responsibilities were divided among staff who already had other competing responsibilities, "the training and qualification program began to lose priority and emphasis."

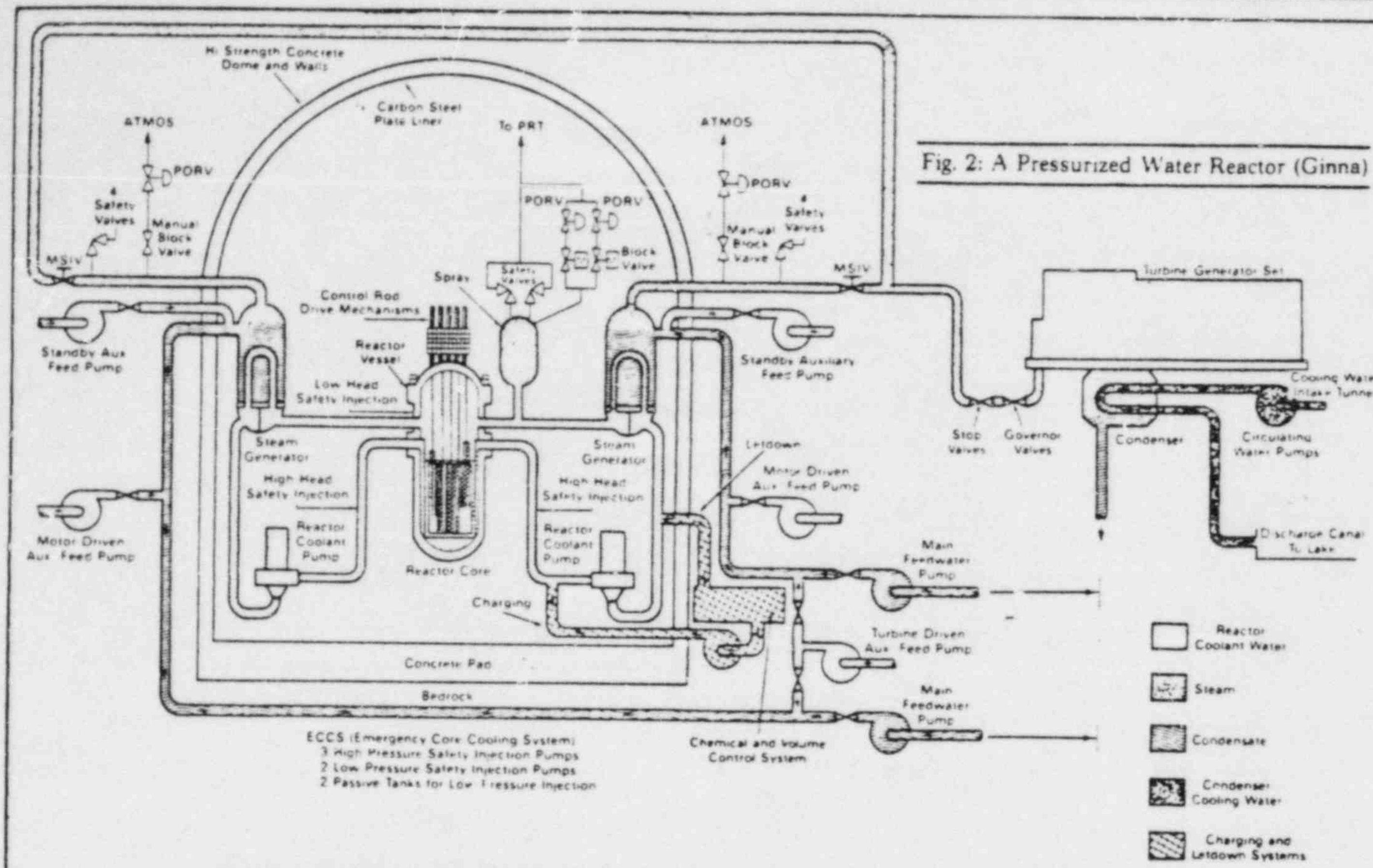
The Three Mile Island reactors offer an example of the need for improved training. An NRC administrative law judge found that there had been widespread cheating on NRC operator-licensing examinations at Three Mile Island, and that several members of the plant management were implicated. In one incident, the Supervisor of Operations at TMI-2 cheated on an examination, and the TMI management lied to the NRC, falsely certifying that he had passed the examination.

References

Precursors to Potential Severe Core Damage Accidents: 1969-1979, NUREG/CR-2497 (1982); Memorandum from William Dircks, Executive Director for Operations, to the Commission, SECY-82-465 (November 23, 1982); Unresolved Safety Issues Summary, NUREG-0606 (1982); A Prioritization of Generic Issues, NUREG-0933 (1983); Three Mile Island Action Plan, NUREG-0737 (1983); Steam Generator Tube Experience, NUREG-0880 (1982); Licensed Operating Reactors, NUREG-0020 (1983).

How Reactors (Often Don't) Work

Fig. 2: A Pressurized Water Reactor (Ginna)



Schematic diagram of Westinghouse-designed pressurized water reactor of Rochester Gas & Electric Corporation's Ginna Nuclear Power Plant
Source: NRC

A nuclear reactor is an elaborate machine made to do one simple thing: boil water to produce steam. The steam generates electricity by spinning a turbine connected to an electrical generator. There are two main types of reactors in the U.S., **pressurized water reactors** (PWRs) and **boiling water reactors** (BWRs).

In a BWR, steam is generated in the reactor core itself. In a PWR, the water flowing through the reactor core is kept under such great pressure (around 2,250 pounds per square inch) that it does not boil. This hot, pressurized water is then pumped through thousands of tiny tubes in a **steam generator**, where a separate flow of water on the outside of the tubes absorbs the heat, turning to steam.

Most U.S. reactors are PWRs, made by Westinghouse, Combustion Engineering or Babcock and Wilcox. Almost all the others are BWRs, of which General Electric made all but one, the **La Crosse** (WI) plant, made by Allis-Chalmers. One plant, **Ft. St. Vrain** (CO), is a high-temperature gas cooled reactor made by General Atomic, that uses helium to transfer heat from the reactor core to steam generators.

The source of the heat in the reactor core is **nuclear fission**, which occurs when uranium atoms in the fuel rods split and give off neutrons, which in turn split other uranium atoms in a chain reaction. To shut down the reactor, **control rods**, which absorb the excess neutrons, are inserted into the reactor core, stopping the chain reaction. If the control rods are not inserted when needed, the reactor can very quickly overheat and start to melt. With a reactor at full power, this can start to happen in as little as 90 seconds. For this reason, automatic systems are designed to shut the reactor down in response to various conditions in the plant. A failure of this system is known as an **anticipated transient without scram** (ATWS).

The major problem to be avoided in a reactor is an inability to cool the core. A **loss-of-coolant accident** (LOCA) can happen if cooling pipes break or through operator error, and can lead to a meltdown and a large release of radiation to the surrounding environment. To mitigate the effects of a LOCA there is an **emergency core cooling system** (ECCS) which can "inject" additional water into the core. The ECCS does not insure that the core will stay covered with water, however, one reason being that steam bubbles can form during an accident, preventing the ECCS water from reaching the core.

Figure 2 illustrates some of the systems in a PWR. The **primary** coolant loop of pressurized water carries heat away from the core, preventing it from overheating and melting. The primary coolant is in turn cooled by a **secondary** coolant loop, which draws off heat by boiling in the

steam generators. After driving the turbine, this steam is condensed to water again by a **tertiary** coolant, which is either water from a river, lake or ocean, or air flowing through cooling towers.

Figure 3 shows the reactor vessel of a BWR, which does not need a steam generator because steam is generated in the reactor itself. BWRs have an additional element not found in PWRs, the **recirculation system** that takes water that has not boiled in its first passage through the core and redirects it, together with the incoming feedwater, toward the bottom of the reactor, forcing it to flow through the reactor core again.

The recirculation piping has been a major source of problems in BWRs, because they develop cracks due to stress and corrosion. A major recirculation pipe break would constitute a very serious loss of coolant accident that could quickly lead to a meltdown. At **Nine Mile Point** (NY), the entire recirculation system had to be replaced because of pipe cracking.

To mitigate the effects of serious reactor accidents, there are many engineered safety systems at nuclear plants, including the **containment building** itself, which is meant to contain any releases of radiation. It typicaly has a **containment spray system** which can spray water into the containment to condense radioactive steam that has leaked from the cooling system, as in a LOCA, so that it doesn't escape to the atmosphere.

These safety systems are designed to insure that a *single failure* will not disable the plant. But the extreme complexity of nuclear plants means that there are a very large number of things that can go wrong, as demonstrated by the increasing number of mishaps that occur each year at nuclear plants, many involving the malfunction of the very safety systems that are designed to protect the public. Even the plant operators do not always understand how the plant works, as with the **Farley** (AL) plant, where the containment spray system was inoperable for eighteen months because the operators could not tell that valves controlling the system had been left shut.

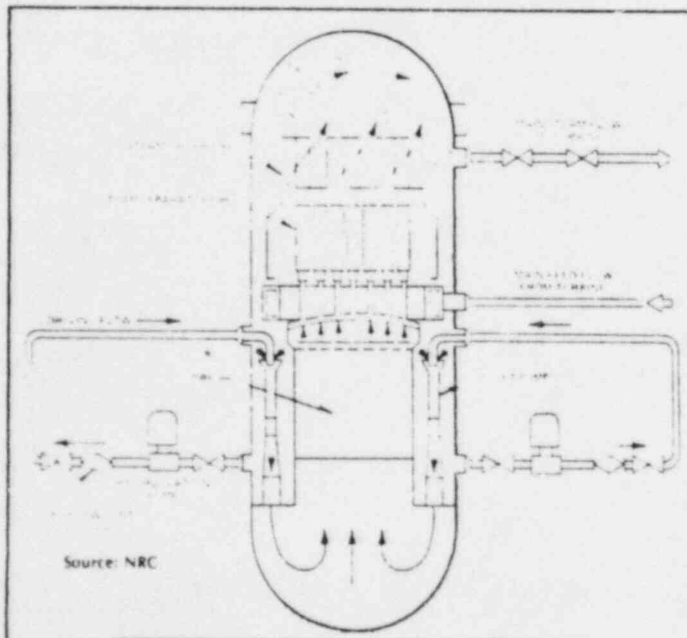


Fig. 3: A Boiling Water Reactor (Grand Gulf)

Methodology

Almost all of the sources used in this report were Nuclear Regulatory Commission documents. The two main avenues of research were the Freedom of Information Act (FOIA) and publicly available material in the NRC's Public Document Room (PDR).

In compiling the total number of mishaps we counted only those mishaps occurring in 1982 for which a Licensee Event Report (LER) was submitted to the NRC. If a mishap was mentioned elsewhere, but we could not find an LER for it, we did not add it to the total number of mishaps, to avoid any chance of double counting. We also read each LER to categorize it by cause: equipment failure, human error, design defect or other cause.

Several sources address those mishaps that the NRC considers to be of particular safety significance, because of the risks they entailed or their safety implications for other nuclear plants. The sources for the list of "particularly significant mishaps" included:

• A computer printout, obtained through the FOIA, showing the ratings of safety significance given to most mishaps by the NRC's Office for the Analysis and Evaluation of Operational Data (AEOD). AEOD gives a rating of "1" to mishaps with such obvious safety significance that they should immediately be investigated further, a rating of "2" to mishaps which appear to be safety significant, and a "4" to those with no apparent safety significance. ("3" is a temporary rating which is changed to either a "2" or a "4".) No ratings of "1" have ever been given since the rating system began, in 1982. Those mishaps rated "2" were counted as "particularly significant mishaps." Unfortunately, AEOD had not categorized all of 1982's events by the time we went to press. Nor does AEOD investigate all of the important events. As AEOD officials have said, "about 30 percent of all LERs have some element which suggests that a followup review is warranted; yet, we study in depth only a portion of these." Thus, AEOD's ratings are an incomplete record pf particularly significant mishaps.

• Memoranda, obtained through the FOIA, that summarize NRC meetings held every two or three weeks by top NRC safety officials to address important recent reactor mishaps. Many important events discussed in these meetings were not reported as LERs, or were unrated or rated "4" by AEOD. Until recently, the NRC rated the mishaps discussed in these meetings according to their safety significance. But, as an NRC official confided to us, because of our use of these ratings last year in compiling the worst mishaps of 1981, they were discontinued. Because the NRC does not now distinguish among these mishaps by their safety significance, we have counted all of them as particularly significant mishaps. This methodological difference makes direct comparison with last year's tabulation of "especially significant mishaps" impossible.

• **Information Bulletins** and **Information Notices** sent

to reactor owners by the NRC Office of Inspection and Enforcement to inform them of important safety mishaps at other plants.

- **Power Reactor Events,** NUREG/BR-0051, a bimonthly NRC publication discussing important mishaps in greater detail than LERs.

- The NRC's quarterly **Report to Congress on Abnormal Occurrences,** NUREG-0090, which lists officially designated Abnormal Occurrences and other safety-related mishaps as well.

We carefully cross-checked these sources to make sure we did not count the same particularly significant mishap twice. The list of the 253 particularly significant mishaps addressed by one or more sources begins on page 18.

NRC Research

If you need facts not found in this report, or want to study a particular plant in greater depth, important information can be found through the Freedom of Information Act (FOIA) and the NRC's Public Document Rooms. Each plant is required to file reports of various sorts with the NRC, and these are organized in separate docket files for each plant. The docket file is broken into subcategories, such as category "S" for all Licensee Event Reports. Booklets describing the NRC's document classification system are available at the Public Document Room, and the librarians there are knowledgeable and helpful, and can even help you conduct computer searches for hard to find material. You can request documents over the phone, which can be duplicated and mailed to you for 5 cents per page.

The main Public Document Room is located at **1717 H Street, N.W., Washington, D.C. 20555, (202) 634-3273.** In addition, there is at least one Local Public Document Room (LPDR) near each nuclear plant. A list of LPDRs across the country appears at the end of this section.

If you need documents that have not been publicly released, you may request them under the Freedom of Information Act (**FOIA**), a landmark enactment giving citizens the right to obtain any government documents that do not fall within certain narrowly-defined exemptions. To request NRC documents under the FOIA, write to **Mr. Joseph Felton, Division of Rules and Records, NRC, Washington, D.C. 20555.** If you plan to publicize or otherwise share the requested information you may request a fee waiver since the information will be used in the general public interest.

For more information on the FOIA, a useful pamphlet, "The FOIA — What It Is and How to Use It," may be obtained free from the **FOIA Clearing House, Box 19367, Washington, D.C. 20036.** A step-by-step guide to using the FOIA, as well as an excellent manual for litigation under the FOIA, may be obtained from the **Center for National Security Studies, 122 Maryland Ave., N.E., Washington, D.C. 20002, (202) 544-5380.**

Local Public Document Rooms

ALABAMA

• Browns Ferry
Maude S. Miller
Athens Public Library
South Street
Athens, AL 35611

• Farley
Bettye Forbus
G.S. Houston Mem. Library
212 W. Burdeshaw Street
Dothan, AL 36303

• Bellefonte
Peggy McCutchen
Scottsboro Public Library
1002 South Broad Street
Scottsboro, AL 35768

ARIZONA

• Palo Verde
Mary Carlson
Phoenix Public Library
Science and Industry Section
12 East McDowell Road
Phoenix, AZ 85004

ARKANSAS

• Arkansas Nuclear One
Mary L. Hudson
Tomlinson Library
Arkansas Tech University
Russellville, AR 72801

CALIFORNIA

• Humboldt Bay
Dee Sockbeson
Humboldt County Library
636 F Street
Eureka, CA 95501

• UCLA Research Reactor
Mrs. Fontayne Holmes
West L.A. Regional Library
11360 Santa Monica Blvd.
Los Angeles, CA 90025

• San Onofre
Ann Douthett
San Clemente Public Library
242 Del Mar
San Clemente, CA 92672

• Stanislaus
Sara Thompson
Stanislaus County Free Library
1500 I Street
Modesto, CA 95345

• Rancho Seco
Diana Gin
Business & Municipal Department
Sacramento Public Library
828 I Street
Sacramento, CA 95814

• Diablo Canyon
Chi Su Kim
Gov. Docs. and Maps Dept.
Cal. Polytechnic State University
Robert E. Kennedy Library
San Luis Obispo, CA 93407

• GETR Vallecitos
Betty Zimmerman
Nuclear Regulatory Commission
Region V, Office of Public Affairs
Suite 300
1450 Maria Lane
Walnut Creek, CA 94596

COLORADO

• Fort St. Vrain
Shirley Soenksen
Greeley Public Library
City Complex Building
919 7th Street
Greeley, CO 80631

CONNECTICUT

• Haddam Neck
Phyllis Nathanson
Russell Library
119 Broad Street
Middletown, CT 06457

• Millstone
Judy Liskou
Waterford Public Library
49 Rope Ferry Road
Waterford, CT 06385

FLORIDA

• Crystal River
Mrs. B. Bonsall
Crystal River Public Library
668 N.W. First Avenue
Crystal River, FL 32629

• St. Lucie
Mrs. R. Scott
Indian River Community College
Charles S. Miley Learning Resources Center
3209 Virginia Avenue
Ft. Pierce, FL 3345[illegible]

• Turkey Point (Emergency Plan Only)
Renee Pierce
Miami-Dade Public Library
Homestead Branch
700 North Homestead Blvd.
Homestead, FL 33030

• Turkey Point
Esther B. Gonzalez
Environmental and Urban Affairs Library
Florida International University
Miami, FL 33199

• Offshore Power Systems (Floating Nuclear Plants)
Susan Derrick
Haydon Burns Library
122 North Ocean Street
Jacksonville, FL 32204

GEORGIA

• Hatch
Mrs. Wynell Bush
Appling County Public Library
301 City Hall Drive
Baxley, GA 31830

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

DOCKETED
USNRC

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

'84 AGO 13 A10:59

In the Matter of	)	
	)	
CAROLINA POWER & LIGHT COMPANY and NORTH CAROLINA EASTERN MUNICIPAL POWER AGENCY	)	Docket Nos. 50-400 OL 50-401 OL
	)	
(Shearon Harris Nuclear Power Plant, Unitl)	)	

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