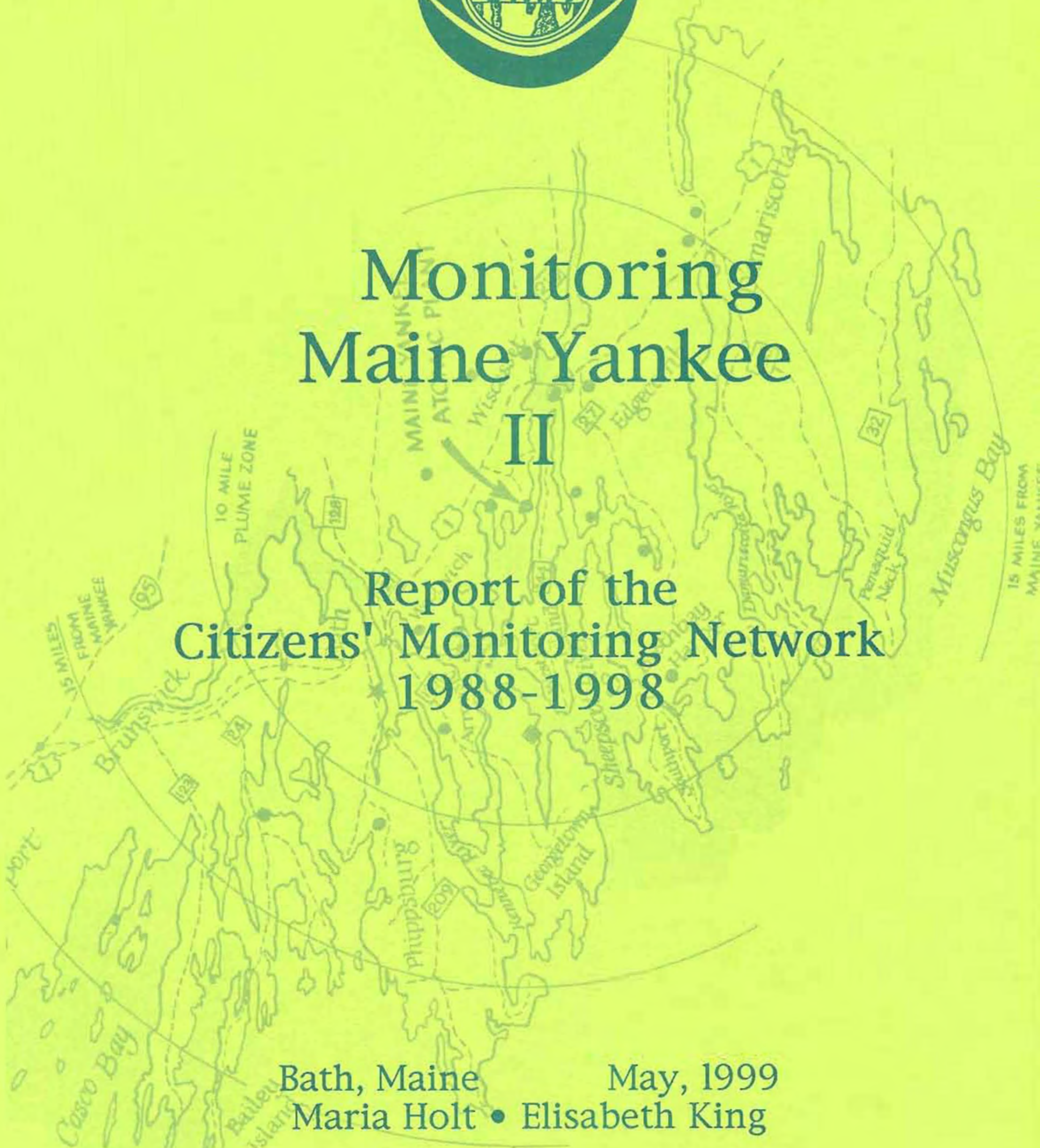
Monitoring Maine Yankee II

Report of the Citizens' Monitoring Network 1988-1998



Bath, Maine May, 1999
Maria Holt • Elisabeth King

ERRATA:

- The legislation which first established the free public information line was passed in 1979, not 1987, as stated in the Appendices.
- On P. 11, the half life of Rubidium-89 is given as 10 years - it actually is 15 minutes, although the decay products are also very radioactive and last a good deal longer.

CMN

citizen's monitoring network
40 ROBINSON ST.
BATH, ME 04530
443-3588
a subcommittee of SAFE POWER for MAINE

DEDICATION

"MONITORING MAINE YANKEE ATOMIC POWER PLANT II" IS DEDICATED TO ALL THE CITIZEN GROUPS ACROSS THE UNITED STATES AND THE WORLD WHICH ARE UNSELFISHLY STRIVING TO AVOID FURTHER POLLUTION WITH MAN-MADE RADIOISOTOPES. THIS REPORT'S OBSERVATIONS MIRROR THOSE OF CMN'S 1988 REPORT. ONCE AGAIN WE RAISE MORE QUESTIONS THAN WE PROVIDE ANSWERS. AGAIN, WE CLEARLY INDICATE THAT THE SOLUTION TO GLOBAL POLLUTION DOES NOT LIE IN THE USE OF NUCLEAR FISSION FOR WEAPONS AND THE PRODUCTION OF ELECTRICITY.

Maria Holt
Elisabeth King

Acknowledgments

Our thanks are due first of all to Will Byers and John and Alan King for creating the design of the original "Black Box" monitoring instruments, which Will built in his shop in Newcastle, and to the many faithful caretakers of the monitoring stations, especially those who were with us from the beginning- Bill Bowers, Seth and Ann Hedgecock, Kinne and Susan Stires, Reynolds and Eleanor Miller, Stan Tupper, Don Hudson, Adolph and Dahlov Ipcar, Bill and Katy Thompson, Lucretia and Mario Pascarelli, Lorraine and Eberhard Schmidt, June and Bob O'Leary, David and Nancy Hall, Shirley Helms, Ron Titcomb, Rufus and Bunny Caswell, Tom and Jan Blevins, Doris Souviney, and Charles King., and most particularly to Ellie Swanson, our faithful recorder.

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We are grateful for the cooperation and assistance of the staff of the Radiation Protection Program in Maine's Department of Human Services, which has been invaluable from the outset of the project. We particularly want to thank Pat Dostie, (who later became the State Safety Inspector at the plant), Clough Toppan, and Bob Schell.

We want to express our appreciation for the community education project which was made possible by Uldis Vanags, Director of Radiation Education Program of the University of Maine., (who has since become Nuclear Safety Advisor to the Governor) and for the assistance of John Arnold, Eric Howe, and other members of the Maine Yankee staff, and also the onsite NRC inspectors with whom we have shared information on many occasions. We have also received much valuable information from The Nuclear Resource Information Services and the Committee for Nuclear Responsibility.

In conclusion, we want to thank Ray Shadis and Friends of the Coast, whose financial assistance made this publication possible.

- Maria Holt
Elisabeth King

Report of the Citizens' Monitoring Network 1988-1998

<u>INTRODUCTION:</u> In November of 1979 an independent Citizens' Monitoring network (CMN), inspired by the accident at Three Mile island, began observing ambient radiation levels in the area surrounding our neighbor, the Maine Yankee Atomic Power Plant (MY). A report describing these observations and correlating them with whatever information was available about concurrent activities at MY was published in 1988*

The present report describes the next decade, from 1988 to 1998, of independent monitor alarms, high readings, and reported planned and unplanned radioactive releases. The information was gathered from Maine Yankee's own toll-free public information line, from the State of Maine Safety Inspector at the plant, from the Radiation Protection program of the Department of Human Services in Augusta, from the Nuclear Regulatory Commission (NRC), and from our own records.

Our CMN radiation records are based on observations made with instruments of our own design and manufacture supplemented by monitoring instruments provided by the State Radiation Protection program. These instruments are stationed in homes within a ten-mile radius of the plant. Some stations are equipped with the original "black box" monitors, some with the monitors provided by the state, and some with both types of instrument.

<u>USING THE MONITORING INSTRUMENTS:</u> The original "black box" monitors were designed to emit an audible "beep" whenever a gamma ray impinged on the Geiger tube. The monitors were calibrated with a commercial Cesium source. Once a week a regular observation is made by counting " per minute" for five consecutive intervals. The number of counts per minute (cpm) was then averaged to give a normal "background radiation" baseline for that particular location. Normal background radiation levels differed from station to station because of differences in the local geology and differences in building materials.

Each station reports the routine readings, and extra readings are made when there seem to be reason to do so. The readings recorded in this log represent readings which were markedly higher than the usual average, and all of them were from the same handful of stations situated near the salt water.

The monitors sound a warble tone alarm at a preset threshold, approximately 10 times normal background level, and continue to sound the alarm until reset. They also stop a clock which then records the time at which the alarm occurred. Above a certain level of ambient radiation the monitors refuse to reset. As a matter of record this happened only three times, and all three were false alarms which occurred when a seat near the monitor was occupied by a person who had just received diagnostic radiation.

*for more detail on the instruments and the network, see the Project Summary in the Appendices

In 1988 the Radiation Control division of the State Department of Health Engineering supplemented our home-made monitors with 50 more , especially made for the purpose. The state monitors had Geiger tubes twice as large, were set to alarm (and stop a clock) at twice normal background level, and they also had digital readouts which eliminated the need to count "beeps." This expanded the network considerably. The locations of the monitors in our network are shown on the map in Appendix I.

THE EFFECT OF WEATHER PATTERNS: We noticed fairly early in the course of our observations that although we had monitoring instruments distributed fairly evenly within a ten-mile radius around the plant, all the alarms and high readings occurred at the stations which were situated near tidewater. This seems to dispel the contention that the alarms were caused by radon events, which would surely not be any more frequent near the tidewater than anywhere else in the area.

We also noticed that these events correlated pretty well with temperature inversions coinciding with still air or low wind velocities. This caused us to seek the assistance of an amateur meteorologist who had for some years made a point of keeping very complete continuous records of local weather conditions in our area. We have developed some hypotheses which might explain the correlations referred to above. (see also Fig. 5)

We know from other studies that under conditions of low barometric pressure, the gases issuing from the Maine Yankee stack do not rise and disperse "harmlessly" into the atmosphere as the NRC computer models assume that they will. Instead they flow downward toward the ground. Anybody who has watched the smoke of a wood stove issuing from their household chimney has observed this effect both with their eyes and with their noses.

We know also these radioactive gases are accompanied by small amounts of radioactive “dust”, referred to in the MY reports as "particulates". These radioactive particulates are sampled periodically by a filter situated in the MY stack. CMN lobbied unsuccessfully for years to have a continuously-reading stack filter feeding information directly to the office of the Radiation Control department of the State Department of Health and Human Services. This kind of instrumentation is in use on stacks of nuclear power stations in Illinois.

Some scientists believe that these “dust” particles, which are too small to be seen by the naked eye, could be captured ("plated out") on droplets of water in fog. Again it is a matter of common observation that the fogs gather first and thickest along the tidewater, and in fact flow along the tidewater as they thicken.

It seems possible that the radiation that was setting off the monitors was associated with these particles of radioactive “dust” trapped in fog or light rain which might be contaminated by gases trapped under a temperature inversion. If this is indeed what was happening, it suggests the sobering thought that these particles could be inhaled by any animal or human being who happened to be outdoors breathing that moist air. (A radioactive particle which is swallowed or inhaled can remain in the body for a long time, and is in a position to do some very serious damage.) This hypothesis would explain why none of the monitors responded to some of the rather large containment purges of gas which were announced on the public information line, and also why they did not respond to all of the Radon events which were reported by the State Inspector.

LESSONS LEARNED: What have we learned in the course of this 20-year-long Citizens' Monitoring exercise? One lesson is: how much can be done without any grant-writing or other formal fundraising. We would not have accomplished anywhere nearly as much as we did, if we had allowed ourselves to be diverted from our purpose by budgets and funding priorities. We would have squandered our very limited resources of time and energy fruitlessly. We haven't made any effort to total up the time and petty cash that we have all put into this project. It is probably much better not to think about it. The point is, that we were able to do all this out of our own pockets and in our spare time- and we are not extraordinary people. What we have done, any citizens' group can do.

Another lesson that stands out is the power of persistence. We did not have more than a small fraction of the number of monitoring instruments which would have been required to discover statistically significant effects, (we had only a few strip-chart recorders - a serious deficiency) we needed many more monitoring stations, and we frankly question the completeness of the records to which we had access from Maine Yankee. There is plenty of anecdotal evidence from workers at the plant to support our skepticism in this regard. And yet, incomplete as the records are, the fact that they were kept over a long period of time has revealed some important patterns.

The most striking of these patterns is; that incidents of high readings and alarms on the citizens' monitors, which had been fairly frequent up until the end of 1990 (especially during refuelling) began to drop off sharply. It was at just about that time that information from the plant became a good deal more plentiful, thanks to the presence of the state inspector and the lobbying activity of CMN members. Most interesting of all is the observation that since the plant went into cold shutdown in 1997 there has been no abnormal activity on any of the monitors.

FROM THE CITIZENS' MONITORING NETWORK DAILY LOG, 1988-1998

1988

April 2: Our J station experienced an alarm at 1:15 P.M. The winds at the time were "onshore most of the day - a funneling effect could have brought gas over the station". This alarm occurred while the strip chart recorder at Maine Yankee was off-line. The plant chemist reported that it was "broke".

April 3: MY announced that during "the last 24 hours less than 9 Curies (Ci.) of radioactivity were released". Liquid releases were increasing at the time from "less than 5 Ci/day" to "less than 10 Ci./day April 2-4. (One Curie represents 37 billion radioactive disintegrations per second - the amount produced by one gram of radium. This unit of radiation is named after Marie and Rene Curie, the discoverers of radium) For comparison, medical usage is usually measured in millionths of Curies.)

December 22: The plant SHUT DOWN again as a result of "all three seals on the coolant pumps failing at once," only five days after a RESTART following a two-month refueling period.

December 28 : CR Station reported "highest readings ever" at 2 P.M. MY reported 50 Ci. of gas vented at this time. Our meteorologist reported that "at 1-2 P.M. clouds lowered from 7000 to 5000 feet, rain and calm winds gave way to dead calm at 3 P.M.. with fog developing." Past experience has shown that weather conditions similar to these have coincided with increased monitor activity, which does not always correlate with radon events and often does correlate with increased releases from MY.

1989

February: A Resident Inspector employed by the State of Maine took up his duties at MY

April 16th: B station (a Radalert monitor) alarmed at twice the usual level at 5:45 A.M. and twice again later in the morning. Readings at the CH station (Chewonki Foundation in Wiscasset) were higher than normal. J station average readings were up from an average of 22 counts per minute to 32 cpm at 9 A.M. and again at 10 A.M., not returning to normal until 3 P..M.. Our meteorologist reported a 500 foot overcast with slow ENE wind and an "intense low pressure system off Cape Cod. Because of these weather conditions, it looks as though this episode was caused by a natural radon event.

November 5 and November 12: J station reported higher readings, up from a usual average of 27 cpm to 48, 45, and 42 cpm, correlating with "SPILL PROBLEMS" reported by MY.

November 8 : MY SHUT DOWN for 10 days following failure of a seal that spilled up to 3,600 gallons of contaminated water inside the plant. According to MY records, it was necessary to vent 3.6 Ci of gases on The night of the 8th. All this month J station readings were in the 30s. During this interval winds were SSE on the 5th and SSW on the 12th, with no storm systems reported.

1990

January-April: HO station reported many alarms during this period while MY was SHUT DOWN for refueling. There were 7 alarms during the month of April alone

April 23: alarm at HE station at 8 P.M.. MY reported "less than 1 Ci." of gas released

May: HO monitor alarmed 13 times during May. Counts during these alarms averaged 60-63 counts per minute (cpm), almost double the normal rate which is 35-40 cpm. for this station. The alarm threshold for this station is lower than most, probably because this house is built of stone and situated on a granite ledge) MY continued to report the release of small amounts of gas, from .01 Ci. to 4.6 Ci., almost daily as it had been doing since March 26th.

June: HO station alarms continued. MY reported increased radioactive releases during early June. Startup for the plant was planned for June 10.

June 4: CA station reported "high readings lately"

By mid-June MY was reporting "less than 1 Ci. of gas and less than 1 Ci. of liquid" every day

June 23: The State inspector at MY reported a radon event.

June 25th: CR station reported high readings.

July 1: HO station alarm, MY at 5% POWER.

July 4: HO station alarm: no gas release reported from MY.

July 5: alarms at both HO and K stations. No releases reported from MY. Weather hot and muggy with a N wind at 15 mph.

July 6: alarm at HO station. MY at FULL POWER, no gas releases reported

July 12: HO station alarm at 5:15 P.M.

July 16: MY reported a small gas release (less than .001Ci."). Small amounts of both liquid and gaseous releases were reported daily during July. Liquid releases increase.

August: MY IS SHUT DOWN again to repair a generator. Alarms continue sporadically at HO Station

August 10 (noon) to August 11: An UNSCHEDULED RELEASE of 1.14Ci. of gas from. MY caused by "an increase in reactor coolant system activity"

August 16-19: SHUTDOWN

August 19: K station reading up from average while MY returned to FULL POWER

August 21: alarm at HO station at 4 A.M.. MY has been reporting gas and liquid releases of from 2 to 3 Ci. /day. HO alarms continue.

August 23: high readings at J station.

August 29: HO station monitor (possibly malfunctioning?) is replaced by the state with another (identical) instrument.

September 1: the new monitor at HO station alarmed at 5:30 P.M. at 61 cpm!

During September 1990 MY went back up to FULL POWER. Liquid releases were reported as "less than 4Ci./day." Gaseous releases were reported at"8 to 8.9Ci./day", some of which were "unplanned" The Maine Health and Engineering staff informed the Citizens' Monitoring Network (CMN) that there were between 4 to 7 leaking fuel rods, and that MY did not know whether the leakage was in the new or the old fuel rods, or possibly due to "debris in the reactor". CMN was assured that radioactive releases would not exceed 1986 levels, which were reported at "no more than 9 Ci. as gas and less than 2,058Ci. as liquid." MY was concerned because "the public is not happy about the releases".

October 1 : MY was SHUT DOWN for one week for "equipment maintenance". Radioactive releases continued at the level of from .001Ci. to 9.2Ci/day. of liquid and .49Ci. to 1Ci./day of gas

October 9:: Clough Toppan, at that time head of the Radiation Protection program at Maine Health Engineering, met with CMN. Mr. Toppan had suggested to MY that they agree to adding some more radiation monitors further from the plant in exchange for letting MY stop reporting radiation releases to the public on their toll-free information line. CMN did not agree to this arrangement. CMN expressed concern that the information on releases from MY did not include small daily continuous and routine emissions. CMN managed to get legislation passed in 1992 which addressed this problem.*

October 19: MY SHUT DOWN again for "electrical maintenance" 111Ci. of gas was released in a purge of containment for a problem created by corroded electrodes. The state inspector reported that "the major part of the release was Xenon-133 (95Ci.) and Xenon-135 (16Ci.).99% of the Iodine-131, amounting to 420 microcuries Ci., was removed by filters."

November: CMN records show that as of this date, in the past five years MY has been off-line for refuelling and maintenance problems for a total of 1 year and 42 days.

December 7: MY SHUT DOWN for steam system repairs. The leak rate necessitated a "quick shutdown."

*for more information on this legislation see Appendices

December 8: MY reported releasing **2.1Ci.** of gas. Light variable winds.

December 9: **J monitor reported high readings** at 43 cpm (average 27-28 cpm) with winds swinging around from NNE to W.

December 15: MY's refusal to deal with leaky fuel rods by replacing them prompted a protest by local people at the plant in cold, wintry weather.

December 17: MY reports that a steam tube leak has been "identified and isolated" The containment was purged on the 17th and 18th. Actual releases totaled 245Ci. of gas and 4Ci. of liquid. The state inspector stated that "most of the radioactive iodine had been filtered out."

December 18: **T station monitor readings doubled.**

1991

MY still **OFF-LINE** for repairs. **Problems with leaky fuel rods and cracked steam tubes continue.** The local paper reported that MY had requested to stop reporting any releases of less than one curie, citing the Nuclear Regulatory Commission's opinion that "one curie poses a negligible risk to the public." Vigorous opposition by CMN thwarted this proposal

January : total releases reported for the month were 25Ci. gas and 62Ci. liquid -On many days in January there was less than 1 Ci. released. The plant went BACK ON LINE on January 13th. We had a false alarm at HE station caused by radiation from a person who had just been given diagnostic radiation. There had been two previous incidents of this kind. In each case the monitor refused to respond to the "reset" button, and the State Radiation Safety Inspector made a house call and diagnosed the problem.

February : total releases were **187Ci. of gas, and 30Ci. of liquid**

March: total releases were **34Ci. of gas, and 39Ci. of liquid**

April : total releases were **19Ci.** gas, and **21Ci.** liquid.

April 30: SHUTDOWN: an "unusual event" at 2:00 A.M. A HYDROGEN BURN took place in the main generator

May: A CONTAINMENT VENT for repair work, released 125Ci.. Additional routine releases were 34Ci. of gas, and 21Ci. of liquid

June 2: **BACK ON LINE: total releases for the month were 16Ci. gas, 44Ci. liquid (doubled since May)**

July: MY is using a new method for testing "grab samples" increasing the volume of air, from 47,000 to 82,000 cubic feet. This may explain the increase in routine gaseous releases which have been showing up in the reports. Total releases for July: 77.3Ci. gas, 32Ci. liquid.

July 23: CMN requested from the Nuclear Regulatory Commission (NRC) a copy of a 1987 document on embrittlement of pressure vessels due to neutron bombardment. This document had just been reported in the press as ranking nuclear power plants in order of problems with embrittlement, and MY was said to be high on the list

August 8: the report, "NUREG CR 2511" was received, but without the list of power plants with embrittlement problems, which never did show up.

August total releases (with MY at FULL POWER): 50.1Ci. gas, 11.3 liquid. September:

August 29: POWER LEVEL WAS DROPPED TO 75% due to problems with a radioactive decay drum.

October: MY releases are now being reported as "approximately" rather than "less than" for anticipated releases, and the actual amounts are reported on the following day. October releases were approximately 8-12Ci. EVERY DAY of combined gas and liquid. CMN had requested a real-time isotopic stack and liquid effluent monitoring system, such as were already in place in the state of Illinois, which would measure and qualify releases at the source. The legislation we requested died in committee, so we had to continue to rely on grab samples analyzed by MY.

November 8: MY reported higher than expected gas releases due to "leaking components"

November 23: AUTOMATIC SHUTDOWN, cause unknown.

December: REDUCED POWER for equipment repairs

December 19: 10Ci. of gas

December 20: back to FULL POWER

1992

January 4: 43Ci. releases because of a "valve problem" Releases averaged 2Ci./day

January 13: SLOW REDUCTION OF POWER to prepare for refueling.

February 9: plant OFF LINE for electrical maintenance on the non-nuclear side.

February 10: the plant began powering up slowly. 40Ci. of gas were released for the first three days, then 20Ci., 15Ci., 40 Ci., and 5CI. for the following days. Total gas released during the CONTAINMENT VENT for refueling totaled approximately 390Ci. gas, and 15Ci., liquid.

February 15: plant was OFF-LINE

March: approximately 1CI./day gas and 1-2Ci. liquid over the month

April 20: STARTUP BEGINS

May: MY reports very small amounts of routine gaseous releases - .2, .08, .04 CI./day

June 15: MY SHUTDOWN because of "steam line malfunction in condenser".

July 2: MY ON-LINE again. Liquid releases have increased to 5-10Ci./day. Steam tube leaks are again a concern.

July 11: CA monitor alarm at 4:20 A.M. Slow winds from the west over the water - possible funneling effect again? MY DOWN IN POWER to 80% for maintenance with less than" **.22Ci. gas and 5Ci. liquid reported.** MY power levels up and down.

July 23 MY OFF-LINE for ten days, because of "corrosion and oscillation problems" in main steam line.

August and September: radioactive liquid releases increased

October: MY LOWERED POWER for eight days to remove mussels from the water intake screens.

November: MY at FULL POWER. Lower releases are reported

December 12: MY OFF LINE.

December 15: MY ON LINE again. 98 Ci., liquid released in December. Steam tube leaks showing up again.

1993

January 4-5: MY SHUT DOWN for night-time repair of a failure of the fan system which prevents overheating of the electrical leads that carry a large amount of current to the main transformer.

January 7-13 saw approximately 10Ci. of liquid released every day for 8 days. The recent shutdowns had produced more water than the borated radioactive water storage tanks could hold. The excess had to be siphoned off and dumped. Approximately 113Ci. of liquid was released in January, with "small amounts of gas, and some short-lived iodine as well" according to the State Nuclear Safety Inspector.

February 2-6: MY SHUT DOWN because of "vibration in the coolant pump" 10Ci. of liquid were released. Daily liquid releases were increasing.

March and April: total releases of 36 Ci. liquid and 4Ci. gas

May and June :totals 59Ci. liquid and 6.5Ci. gas released.

July: MY GOING OFF LINE all month preparatory to refuelling.

July 1: HA station experienced three alarms and some high readings -(60, 48 and 52 cpm -twice the normal average). Slow winds from the SE. over the water The HA station is due east from MY., which reported .5 Ci. gas that day and approximately 3Ci. on the previous and following day.

August; total gas released prior to this refuelling was "approximately 45Ci." The plant chemist stated that this was a better(less leaky) load of fuel.

September OFF-LINE for refueling.

October 19: BACK ON LINE

November and December: MY at FULL POWER. Total liquid released, 15Ci., gas, 11Ci., liquid.

1994

February releases: approximately 7 Ci. liquid and 1.6Ci. gas

March releases: approximately 41Ci. liquid and .4 gas

April releases: approximately 13 Ci. liquid and .5Ci. gas

May 9: approximately 11.9Ci. liquid released

May 19, 20, 21 MY SHUT DOWN for maintenance on the non-nuclear side.

May totals: approximately 18 Ci. liquid and "less THAN 12CI., gas."

June 11; MY released 8Ci. of liquid. Gas releases remain steady.

June 23: MY "service water sprung a leak" allowing salt water to get into the steam generators.

June 24: SHUT DOWN for five days while the water was siphoned off and discharged overboard, along with approximately .5Ci. of radiation.

July: MY RETURNING TO POWER, but SHUT DOWN again on July 16th for the rest of the month. Tube leaks were increasing. Total releases 61Ci. liquid, approximately 66 Ci. gas. There was a marked increase in steam generator leakage, which had been doubling every 60 days and was now doubling every 30 days. Although 300 steam tubes had been "plugged" already, the leakage problem persisted.

August: totals, approximately 94Ci. liquid, approximately 12 Ci. of gas.

August 3: false alarm at J station, which turned out to be due to radiation from a household member who had just received diagnostic radiation.

August 17: MY BACK TO FULL POWER.

September: 11 Ci. of liquid and "less than" 9 Ci. of gas.

September. News reports that a group of University of Maine students were exposed to radioactive Rubidium gas while visiting the plant caused a flap at MY and in the Maine media. A state radiation control staff person stated that the only reliable guide for assessing the dose was the three thermoluminescent dosimeters which were worn by the guides, which showed a dose "equivalent to one dental x-ray". This would not have included the dose from inhaled gas, which according to Dr. Ernest Sternglass must have included some Rubidium-89 which has a half-life of 10 years and is both a gamma ray and a beta particle emitter.

October: total releases: approximately 2Ci. liquid, .5Ci. gas

November: MY decreasing power for maintenance on the secondary side.

November 3-9: SHUT DOWN.

November: total releases were approximately 6Ci. of liquid and .7Ci. of gas.

December: FULL POWER : releases: approximately 40 Ci. liquid, 1Ci. gas.

1995

January: MY SHUT DOWN for refueling and repairs. Total releases for the month were approximately 54 Ci. of liquid and 2Ci. of gas.

February; continued shutdown for repairs and refueling; approximately 13.5Ci. liquid and 32Ci. of gas released.

February 10: CMN received a phone call from a worker at MY expressing concern
that sludge dredged from the seawater intake area was being dumped on a field on MY property just 200 feet from tidal water. CMN contacted the state inspector who explained that dredging had been going on for the last few months to get sediment out of the area around the intake and outlet . The sediment contained "minute traces of radioactive cobalt, cesium, and silver. Radioactivity of this material was measured by MY at 50 pico-curies/gram." This material was to be planted over with vegetation to keep it from washing into the river. It will be considered low-level waste at the time of decommissioning. The longest half-life in this material, 30 years, was the Cesium. It will be considered hazardous to human life for 300 years.

February 13: at 1 P.M. K station reported high readings. MY reported a release of .3Ci. of gas on the previous day and 3Ci. on the following day.

February 24: high readings at K station again, where readings were being recorded continuously on a strip chart recorder, which showed the highest readings on record: twelve to 15 counts above the normal average. for twelve readings within one hour. No unusual activity being reported from MY, and no radon event which would explain these readings. Very puzzling.

March: more steam tube cracks discovered: total releases reported were approximately 14Ci. of liquid and 6Ci. of gas.

April: the refueling outage continues, with releases of approximately 8Ci. of liquid and 3Ci. of gas. Re-racking of the spent fuel (placing the rods closer together in order to accommodate more spent fuel rods in the available space) has been postponed.

April 11th: an anonymous call from a worker at the plant: "as of Friday, everybody is laid off...even the regulars. MY is looking for bids to do repair work ...non-union!"

May: releases continue during shutdown

June: MY was " sleeving faulty steam tubes." Approximately .06Ci. liquid and 13Ci. gas.

June 14: CMN received an anonymous call from a worker who believed that he had been overexposed to radioactivity while working at MY in 1993. According to this statement, while doing work (for which he was untrained) at night on a steam generator, he was told by a MY healthphysics staff person that his dosimeter "was not giving a reading" and to come down from his station to have it "readjusted". (This doesn't make sense because the dosimeters measure cumulative dosages and are read periodically - they aren't designed to give continuous readings.) This worker subsequently suffered temporary paralysis of one side his face, lost hair and experienced general disorientation. He was referred by a local practitioner who worked with MY to an out-of-state specialist (who turned up earlier as an advocate in legislative hearings on behalf of Maine Yankee). No physical examination was performed. CMN was not in a position to offer any help to this worker who had been told that his exposure was "less than a dental x-ray"

July and August: resleeving of the steam tubes continued at MY. Approximately .08 to .13Ci. of gas along with small amounts of liquid were released daily.

September: the State inspector told CMN that this time of inspection of the steam tubes by "non-destructive radiography is advancing the nuclear industry up a learning curve." Our translation: "this is an experiment."

October: small daily releases continue.

November: The news broke on a letter from a MY whistleblower. The letter stated that computer codes governing the safe operation of the core cooling system and the reactor vessel containment had been altered, without notifying the Nuclear Regulatory Commission (NRC), on two occasions in order to raise power output. Cooling water pump vibrations are again a problem. Total releases: approximately 6.2Ci. of liquid, 2.2Ci. of gas.

December: small releases continue.

1996

January: slow STARTUP of the plant after completing the re-sleeving operation. The NRC has required that power level be limited to 90% while an investigation proceeds. Releases total 22Ci. liquid, .24Ci. gas, almost all of it within the first three days.

February 22: liquid release up slightly, to .5Ci.

February 23: HO monitor alarmed at 10:50 A.M.. ENE wind at 4-12 mph. MY reported no unusual releases. Gas is being reported as "less than .01Ci./day".

February 29: an ACCIDENT AT MY exposed 18 workers to radioactive gas.

March 1: the NRC reported that 18 workers had been accidentally exposed while inside the primary auxiliary building. All the dosimeters set off alarms. Doses were being calculated. It wasn't until 1998 that CMN got the results: 146 millirems calculated as a whole body dose. There is no way of knowing how much of this radioactivity was inhaled into the lungs and passed from there into the bloodstream Radioactivity ingested in this way has a much greater potential for damage than a dose to the skin, which acts to some degree as a barrier. An "unscheduled release" of .17Ci. gas accompanied this accident.

April, May and June: total releases : 17Ci. of liquid, and .9Ci. of gas

July: MY SHUT DOWN for "design modification of faulty cooling system" and an inspection by the NRC.

August: MY SHUT DOWN for most of the month because of "electrical problems in the cooling system." Total releases, approximately 100Ci. liquid and 25Ci. gas. All of this falls within the range of "normal plant activity." Power vacillated up and down until September.

September: MY BACK ON LINE at 90% power. total releases: approximately 66Ci. liquid and 7Ci. gas

October: new racks for the spent fuel pool are to be installed soon. The NRC investigation continues. 29Ci. liquid and .6Ci. gas total.

November: total releases were 83Ci. of liquid and 3.6 gas.

December 5: SHUTDOWN. The NRC disclosed that the Independent Safety Assessment Team found incorrect routing of electrical cables. Total releases; approximately 14.Ci. liquid, 4.5Ci. gas

December 31: MY went into COLD SHUTDOWN for repairs ordered by the NRC.

1997

January 3: the reactor head was removed in order to inspect the fuel rods. Total releases: 53Ci. liquid and 56Ci. gas.

February; cold shutdown continues, although a startup is still planned. Total releases; approximately 15.4Ci. liquid, 2Ci. gas

March: around-the-clock work on re-racking the spent fuel pool. Total releases, approximately 22Ci. liquid and 1Ci. gas.

April: the plant has been shut down since December 5th. Total releases: 19Ci. liquids, "less than" 5Ci. gas.

May: totals: approximately 8Ci. liquid , "less than" 5Ci. gas

June: approximately 1Ci. liquid, "less than" 4Ci. gas.

June 28; MY reported that <u>a worker had accidentally let 10,000 gallons of cooling water out of the spent fuel pool.</u>

July: **MY failed the NRC safety inspection.** Stockholders refused to pay for more repairs. MY management pondered whether to sell the plant or close it down permanently. Cheaper, Safer Power planned a successful referendum campaign to stop MY from operating after the expiration of its license in 2008. CMN sent a letter to the only potential buyer, the Pennsylvania company PECO, presenting our work to date and assuring them that it would go on whoever owned Maine Yankee

August: PECO decided not to buy. <u>Maine Yankee was defuelled and ready for decommissioning.</u>

<u>There has been no unusual activity reported on any of the monitors since February 1996.</u>

APPENDICES

The Citizen's Monitoring Network: A Project Summary

In the aftermath of the accident at Three Mile Island, a small group including a molecular physicist, several retired engineers, the proprietor of a small electronics company and a high school science teacher met in Woolwich, Maine. The agenda of the meeting was to discuss whether they could not, with their combined backgrounds and skills devise a warning system which would not leave them at the mercy of the nuclear industry and the state bureaucracy in the event of a similar accident at the nearby Maine Yankee nuclear power plant.

They were originally thinking of something as simple as a smoke detector, intended to serve a similar function with respect to unusually high levels of ambient gamma radiation. Gamma, because gamma is by far the largest (though not necessarily the most dangerous) component in the radioactive emissions from the stack of a nuclear power plant, and would thus be easiest to "see", so could serve as a tracer for the radioactive plume.

Gamma radiation also passes easily through the roofs and walls of houses (unlike alpha and beta radiation) to the interior, where the monitors would be situated. The major component of the plume, which should be easily detected, would be the $Xenon_{133}$ which emits gamma radiation at an energy level of about 80 KEV.

The design for the device rapidly evolved into something considerably more sophisticated than a smoke detector. The "black box" was christened "countermeasure", by its creator, Will Byers, of Newcastle, Maine. There is a little speaker which emits a steady chirp in response to incoming radiation striking the geiger tube. There is also an electric clock plugged into the unit. The alarm has a delay built into it, so that if radiation increases to a level of about ten times background and persists at that level for more than a certain interval of time, the "beep" will change over into a warbling tone, and the clock will stop. The time delay is to filter out brief transients such as might be caused by cosmic ray bursts, for example.

The stopped clock will place the event in time if there is nobody in the house to notice the alarm tone. It became important to know the time of the event exactly when the idea emerged that we might group the (admittedly low-precision) devices in such a way as to gather information from the patterns in which the alarms occur.

For example, a check against erratic behavior by any one monitor can be made by comparing it with another monitor nearby. If only one of the devices is sounding the alarm, the chances are that this is a purely local effect or perhaps a malfunction of the device. (e.g., we have more than once had alarms set off by the presence of individuals who have recently undergone radiotherapy). If, on the other hand, both devices sound the alarm together, there is a presumption that a real radiation event may be taking place.

An effort is also made to locate the monitors along straight lines radiating away from the power plant. It has happened on several occasions that a nearby monitor has alarmed, and ten or fifteen minutes later another alarm has sounded further out along the radius. This kind of event can be correlated with wind speed and direction, low cloud cover, and/or temperature inversions.

Most of the alarms which we have experienced have occurred during periods of little air movement, low cloud cover, light rain or fog. There also seem to be a disproportionate number of alarms along the waterways, of which there are many on this part of the coast. We have reason to believe that gases tend to travel along the water when, on occasion, we smell the effluents from the paper mill far away in Westbrook, near Portland, a distance of perhaps forty miles. The fragrance from the paper mill seems to travel along the Androscoggin river, through Merrymeeting Bay, down the Kennebec, and around the corner out the Sasanoa river.

The gases from the power plant are also heavier than air, though they rise when the initially leave the stack because they are hotter than the surrounding air. As they rise, however, they expand and cool, and if they meet a stratified layer of warm air they may sink toward the earth once more. This kind of behavior is called "fumigation" , and it is under conditions of fumigation that the radiation contained in the plume is likely to be encountered by the human population.

It will be seen that we have here a social invention equal in importance to the technical invention of the monitoring device. The social invention is the reporting network through which the behavior of the monitors is noted and compared and correlated with weather conditions and reported activity at the power plant.

The keepers of the devices (which belong to the network) are required to take regular readings, counting the "beeps" which signal incoming radiation impacts on the geiger tube. We now have logs of gamma levels at some twenty locations going back seven years, with alarms duly noted. The most significant observation that we have made is that gamma levels are remarkably stable for each location, though they do vary from station to station.

This variation may be accounted for by the difference in the geologic composition of the building site or in the building materials. We do <u>not</u> see seasonal variations, such as would be caused by Radon gas in snow melt, for example. We do think we see more activity during periods of temperature inversions such as typically occur in Jaunuary and again in August.

When we first began looking at Gamma levels at Hockamock Bay Farm, back in December of 1979, we had a chance encounter with what now appear to be an extraordinary series of radiation events. The black boxes were still in the works, and in the interval we were using a Nuclear Chicago Class-Master Model 1613A detector, calibrated with a standard Cesium source and connected to a strip-chart recorder.

At about 10 P.M. on December 7, the noises from the recorder accellerated until they sounded like corn popping, and when we looked at the chart to see what was going on, we saw a really remarkable disturbance, the first of many which we were to observe during the following five weeks (see figures). The counting rate rose rapidly in about 30 seconds to about fifty times background level, then decreased much more gradually in a generally logarithmic manner over the next half-hour.

Since we had only just begun to continuously monitor gamma levels, we had no way of knowing that this wasn't perfectly normal, so we continued to observe through the rest of December and well into January. The last of these disturbances occurred on January 7th. After that, there was nothing.

After about six weeks of a steady 20-50 counts/minute with no further excitement, we began to wonder what we had been looking at during December. The first explanation which came to mind was cosmic ray bursts. We went down to MIT and talked with Dr. Rossi, the cosmic ray expert. Cosmic ray bursts apparently never last longer than a couple of minute at athe most (we can see them on the trace, but you have to look pretty hard.)

The shape of the curve is wrong for radon outgassing, which would have a more gradual rise and fall, and might be expected to correlate with seasonal outgassing from melting snow and/or with water use in the house, neither of which checked out with the record on the tape. The general shape of these large disturbances is what one might expect from the bursting of a balloon, or the sudden opening of a gas-containing tank, the gas being carried slowly overhead on a non-turbulent wind.

The energy contained in the largest of these disturbances can be back-calculated as about what you would expect from a cloud of 3 ci at about 100 ft. above ground level. Summing up all the energy represented by the disturbances which we witnessed, we get an amount of radiation which is not inconsistent with the recorded releases from Maine Yankee for this period.

The plant was at this time going into a cold shutdown in preparation for a refuelling operation which included the replacing of nine leaky fuel rods. The end of this operation coincided roughly with the end of the large disturbances on out monitor. While we have not established a connection between the two, nobody has yet come up with any better explanation.

We have an improved model of our black box which sums up counts and prints them out, hour by hour. What we would like to do now is to connect this arrangement with a memory tape (such as in used in intensive care units) which would switch itself on in reponse to a large amount of incoming radiation, remembering the ten-second interval preceding the event, and print all this out so that we could get a good look at the profiles of the incoming radiation during the intervals during which gamma levels are particularly high. The hypothesis is that we might expect to see more fast-rise, slow fall disturbances such as we happened to observe, purely by chance, at the outset of our monitoring work.

The emphasis has clearly shifted from an early-warning system, which was the original concept, to a study of routine releases from the plant, which may be connected to documented concentrations of illness in neighboring populations (see figure)

Another useful development which may not be too difficult would be a way of filtering out everything but gamma radiation in the 80KEV range, which would link the monitoring definitely to Xe_{133}. We now have, newly on line, a multichannel analyser with which we can looks at biological samples. It would be interesting to check sites of high gamma activity for the presence of Cs_{134}, a decay product of Xe_{133} which is uniquely a product of nuclear power generation and not present in bomb fallout. This would be a "fingerprint" for the presence of the plume from the power plant, and would serve to link the increases in gamma radiation which we are looking at with Maine Yankee.

Hypothetical links betwen the Xe_{133} and illness in the surrounding human population could include direct irradiation from the "cloudshine" of the plume, and also the direct inhalation of the gas under fumigation conditions. Xe_{133}, if inhaled, can bond with body fat e.g., in mammary tissue or the fat in bone marrow.

Over the years we have established strong links with the State Department of Health Engineering and with the NRC inspectors at the plant, with whom we regularly share information. We now have access to day-by day records of radioactive emissions (previously available to the public only after a two-year delay in publication) which we get at the end of the month from the NRC via Health Engineering.

There is also an 800 number which gives anticipated emissions for the next 24 hours, and we recently protested a large anticipated release with the result that the gas was release over a period of three days instead of all at once. We immediately notify the plant whenever we have an alarm, and we feel we may have raised a few questions by sharing that information. They in turn are willing to share with us the details of events leading up to unanticipated releases when they occur. We have learned a lot about the operation of the plant and we continue to learn.

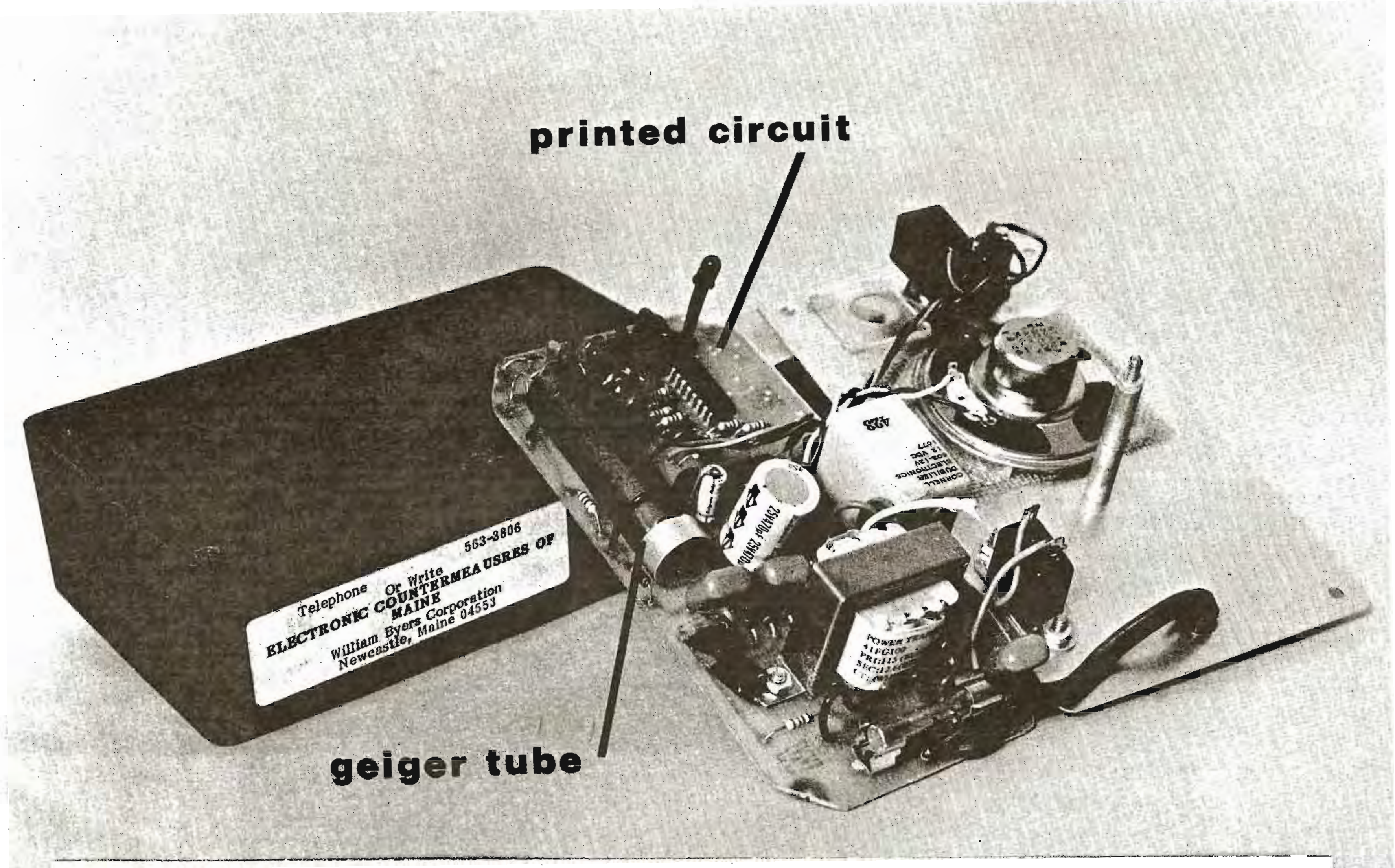


Figure I: The original "Black Box" monitor, designed by John and Alan King and Will Byers, and built by Will in his shop in Newcastle.

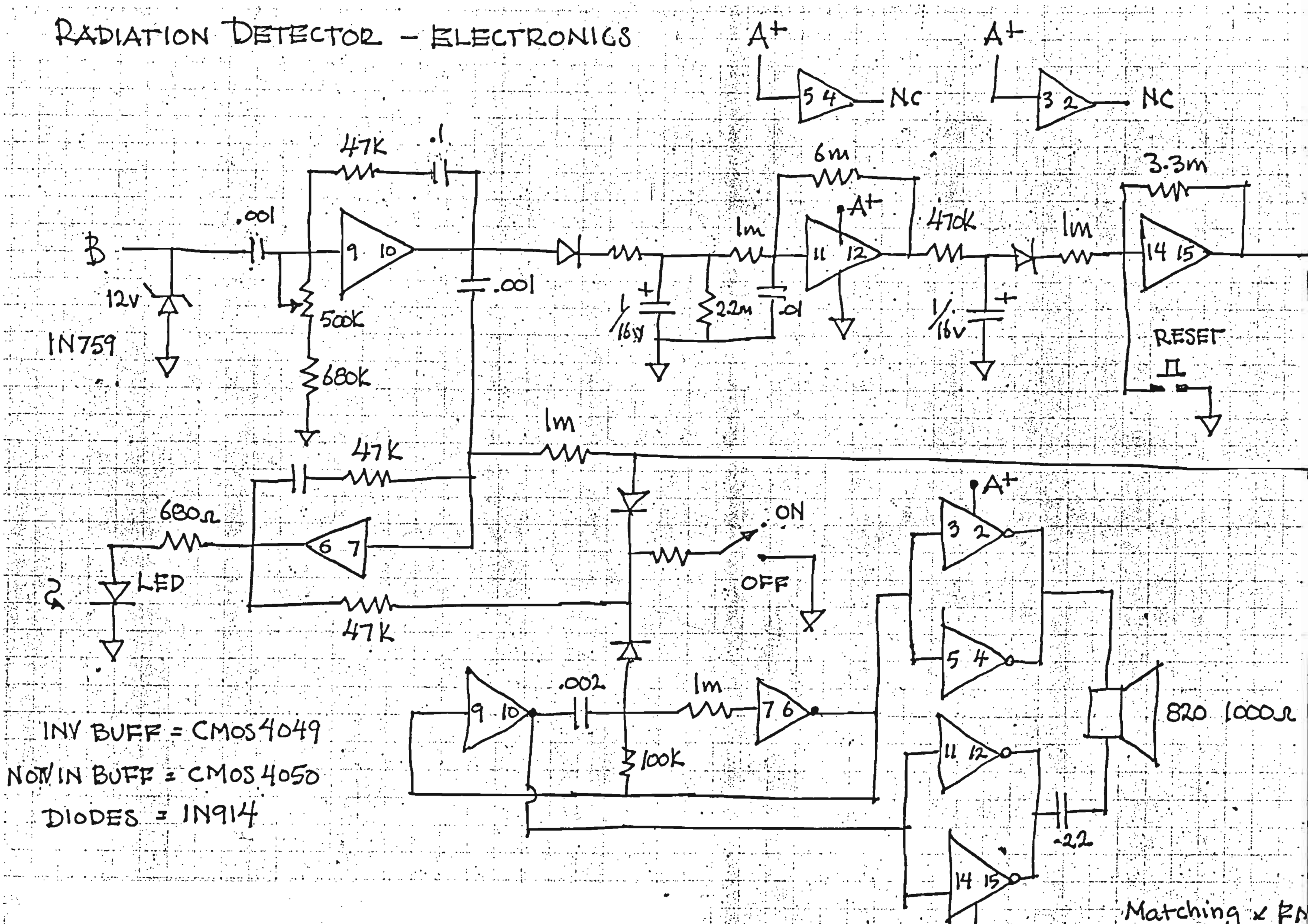


Figure II: Circuit diagram of the "Black Box "

T_1 = #N320 GM TUBE, TGM DETECTORS, INC. 34 BEAR HILL ROAD, WALTHAM, MASS

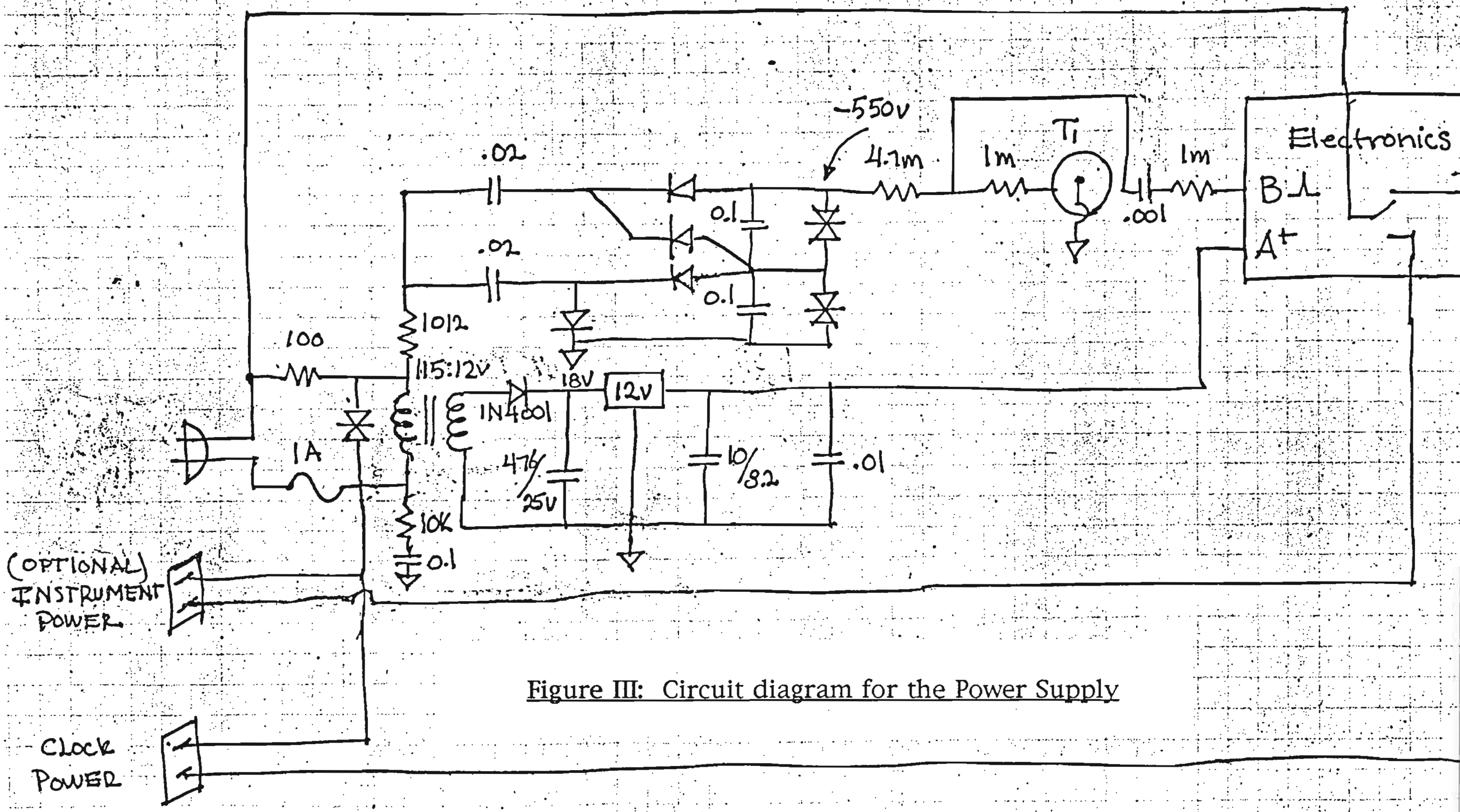
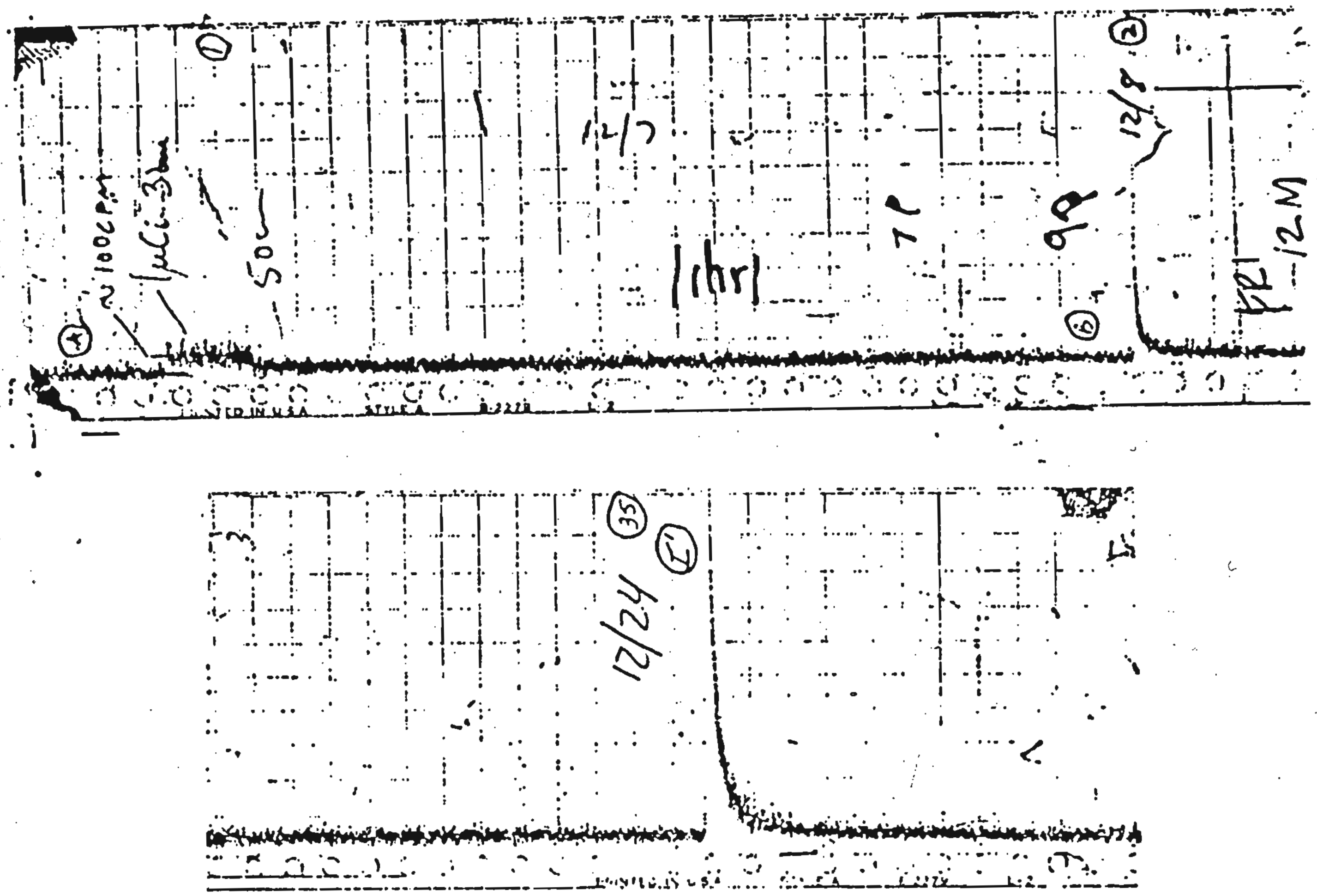


Figure III: Circuit diagram for the Power Supply

MOV - GE # MR 330-5 CLAMPS AT 275 V

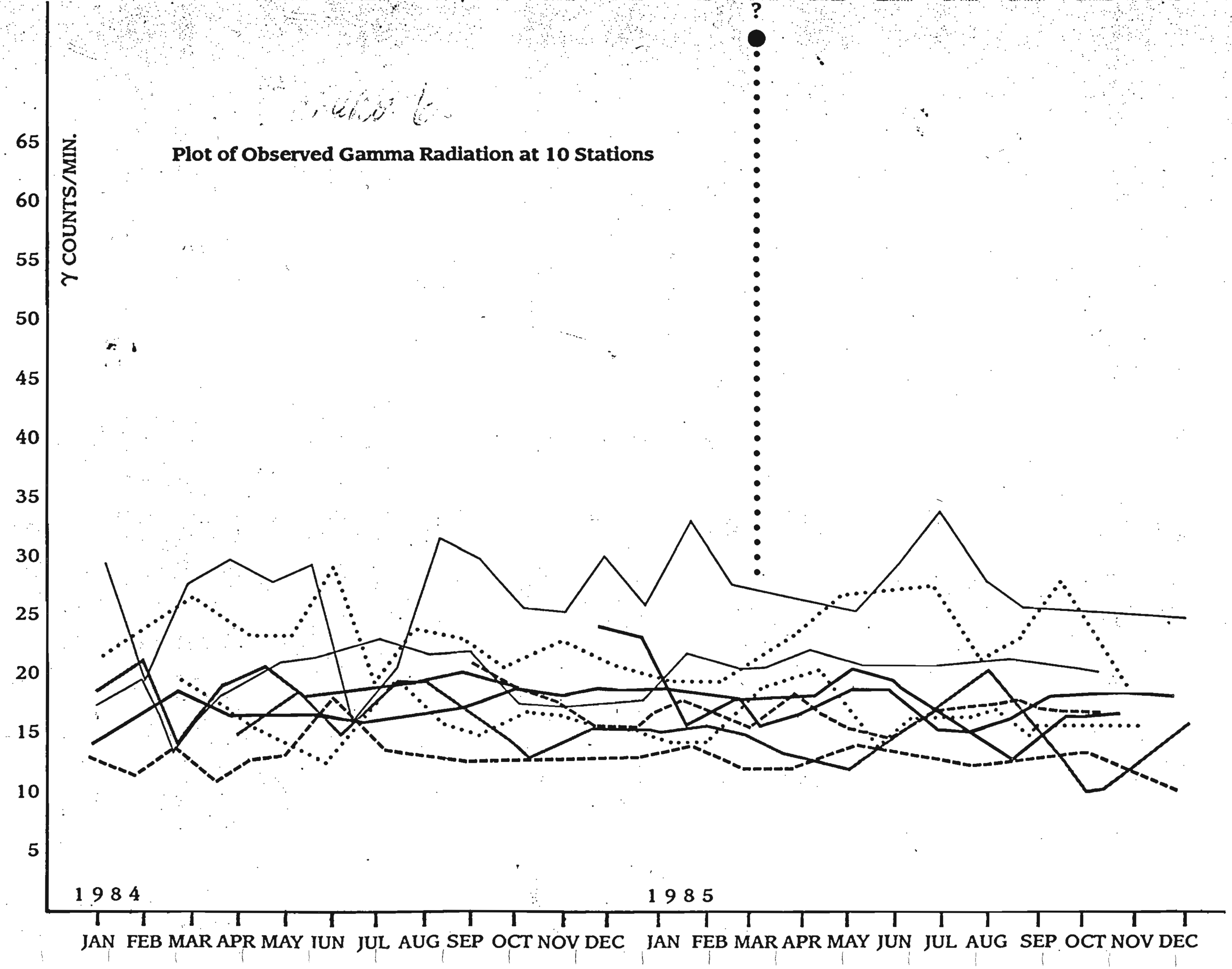
POWER SUPPLY
- RADIATION DETECTOR



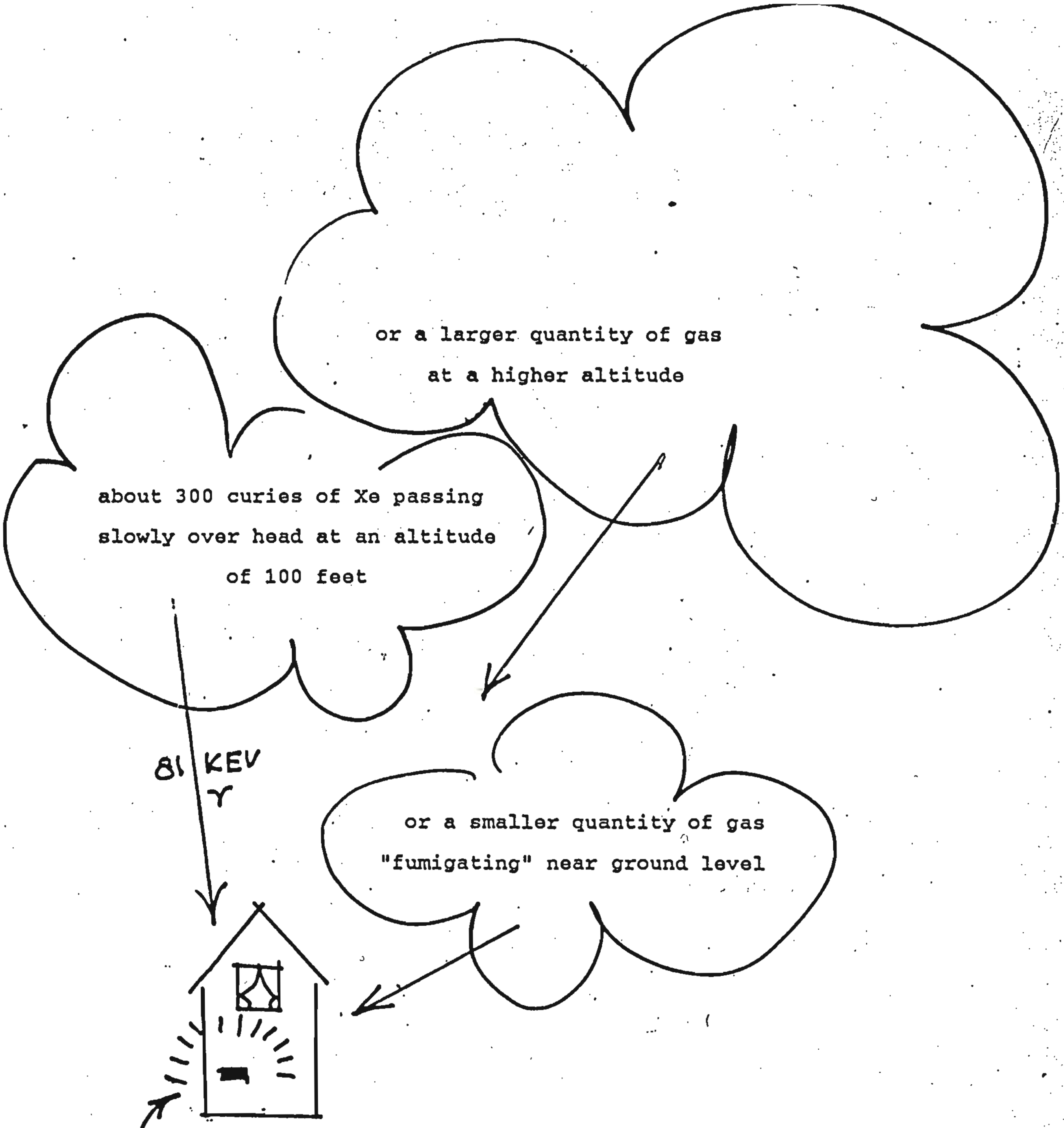
TWO PIECES OF RECORDER TAPE, SHOWING REPRESENTATIVE DISTURBANCES.

These two pieces of tape are part of over thirty feet that were run through the recorder in the period from December 7, 1979 to January 7, 1980. The paper moves at one half-inch per hour. Full scale is about 1500 counts/minute. The noisy trace along the bottom of the paper represents the background -- something like 20-50 counts per minute. The upper piece shows the calibration that was made by holding a 1 micro-curie Cesium 137 source around 3 cm from the GM tube. At around 7:40 PM on the 7th of December, one of the short, fast-rise-and-fall disturbances can be seen. Since the impression of the recorder needle is made every two seconds, one can deduce that the entire disturbance lasted around 30 seconds. At nearly 10 PM, a larger disturbance can be seen, whose rise is fast (less than a minute), but which requires about 15 minutes to fall back to background. Near the center of the lower piece, one can see an even larger disturbance, which rises in about 30 seconds, and requires more nearly half an hour to fall back to background. Three and a half hours later, there is another fast rise-and-fall disturbance. The general shape of these large disturbances is what one might expect from the sudden opening of a gas-containing tank, and the gas being carried overhead on a non-turbulent wind. The gradual fall of the large disturbances back to background is also characteristic of what one might expect from emptying a tank, or decay drum. Whether the short rise-and-fall disturbances are of the same kind, or of quite different origin (including natural occurrence) is not known.

<u>Figure IV: Traces from a strip - chart recorder</u> - recording some typical radiation events at K Station



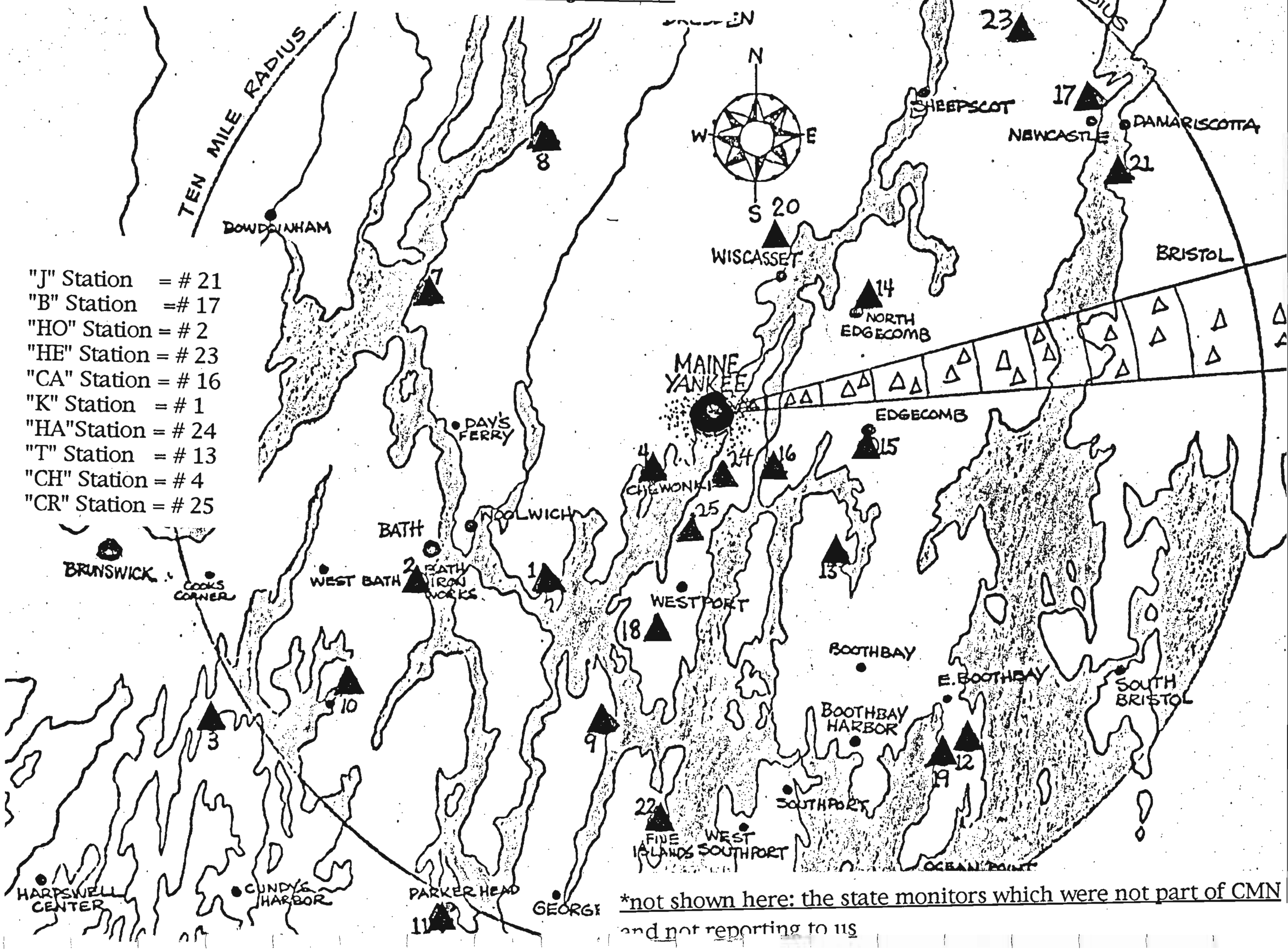
Plot of Observed Gamma Radiation at 10 Stations
γ COUNTS/MIN.
65
60
55
50
45
40
35
30
25
20
15
10
5
1984
1985
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
?



A POSSIBLE EXPLANATION OF ACTIVITY SEEN
ON OUR 'BLACK BOX' MONITORING INSTRUMENTS

Figure V: The hypothetical effect of clouds of radioactive gas overhead

Figure VI: The locations of the CMN monitoring stations*



*not shown here: the state monitors which were not part of CMN and not reporting to us

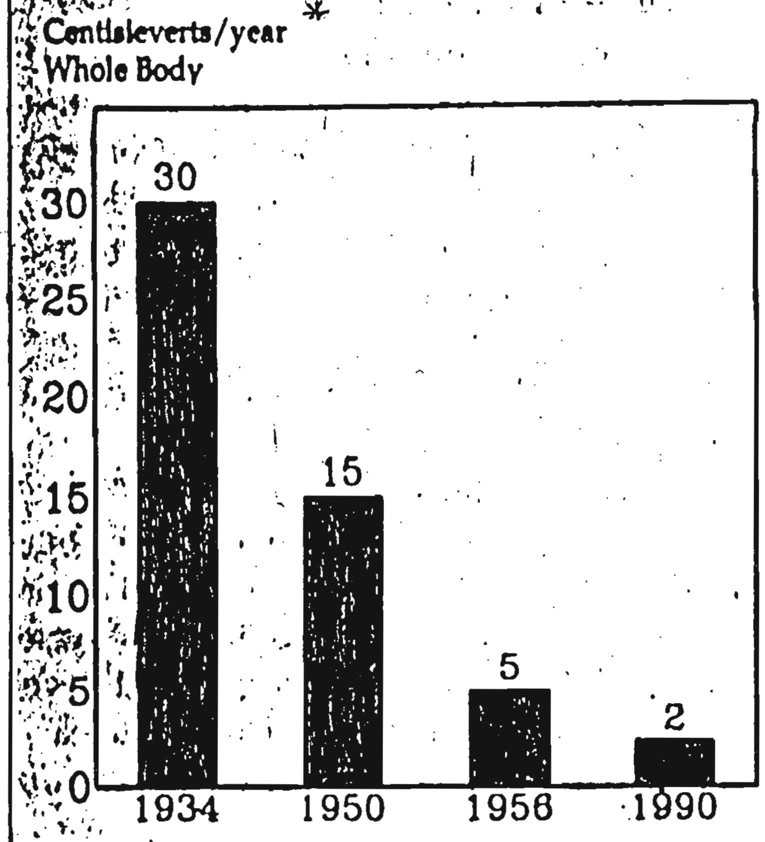
Figure VII Some of the hundreds of radioctive elements routinely released from nuclear power plants. Most of these are not found in nature. Some are created in large amounts and some in very small amounts. As will be seen in **Figure IX,** the number of curies released into the air and water over the course of a year frequently exceed the number of curies shipped out as low level waste.

Hydrogen-3 (Tritium)	12 year half life*
Chromium-51	27.8 days
Manganese-54	303 days
Iron-55	2.6 years
Cobalt-58	71 days
Cobalt-60	5 years
Nickel-59	80,000 years
Krypton-85	10 years
Strontium-89	53 days
Strontium-90	28 years
Silver-110	249 days
Antimony-125	2 years
Iodine-129	17,200,00 years
Iodine 131	8 days
Xenon-133	5 days
Cesium-134	285 days
Cesium-137	30 years
Cerium-144	285 days
Plutonium-239	24,390 years**
Plutonium-240	6,480 years
Plutonium-241	13 years
Americium-241	458 years
Curium-243	35 years
Curium-244	18 years

* the half-life of an element is the time it takes for half of the isotopes to break down into other elements (which are frequently also radioactive) Radioactive isotopes are considered to be dangerous to life for ten times their half-lives.
The most dangerous to human life are those with half-lives closest to that of a human being, since this allows maximum opportunity for exposure. Some of these are also more likely to be ingested. Ingested doses are much more damaging -because of the proximity to vital organs, and also because they can remain in the body for a long time. The "safe level of exposure " as reported by the International Commission on Radiological Ptrotection keeps dropping (see **Figure VIII**)

** Plutonium is also one of the most toxic chemicals known to man.

HOW "SAFE" HAS CHANGED OVER TIME



"In the first five decades of the Nuclear Age, the international recommendations for acceptable levels of worker exposure to radiation have been revised downward a number of times. The dangers of exposure to low-level radiation have been historically underestimated."

Dr. John Gofman is among the growing number of specialists in the field today who assert:

"THERE IS NO SAFE LEVEL OF RADIATION EXPOSURE."

Source of graph: International Commission on Radiological Protection; Caufield, as reported in Worldwatch Paper 106.

<u>Figure VIII: how limits for allowable exposures have changed over time.</u>

* one Centisievert = 1000 millirems, or one Rem

Table 1

MAINE YANKEE RADIATION RELEASES

The table below summarizes the total radioactive gaseous and liquid released by Maine Yankee as reported to the Nuclear Regulatory Commission in curies per year.

GASEOUS:	1983	1984	1985	1986	1987	Federal Limits*
Noble Gases	39.2	122.7	440.9	1073.03	780.0	100,000
Iodine-131	0.00002	0.00240	0.000302	0.00216	0.00131	30
Total Halogens	0.00002	0.00242	0.000566	0.00284	0.00161	30
Particulates	0.00005	0.022	0.0001126	0.00055	0.00119	30
Tritium	5.30	4.81	2.729	6.048	3.062	60,000

LIQUID:						
Mixed Fission & Activation	0.200	0.086	0.03115	0.2985	0.8806	60
Total Tritium	286.3	172.3	183.81	349.5	117.71	48,000
Noble Gases	0.005	0.018	0.1632	1.419	1.502	3,800

**Limits as specified in 10 CFR-20 based upon nuclides released.*

Table 2

MAINE YANKEE RADIOACTIVE RELEASE EXPOSURE IMPACT

The calculated annual radiation exposure to persons living in the vicinity of the Maine Yankee plant, as a result of the releases listed in Table 1, is very small compared to the natural background of approximately 85 mrem per year.

Nearest possible dwelling:
The calculated* whole body radiation exposure to a hypothetical person living 100 meters** from the plant is summarized as follows:

RELEASES in mrem	1983	1984	1985	1986	1987	License Limit***
Gaseous	0.001	0.009	0.026	0.0271	0.011	10.0
Liquid	0.005	0.001	0.0005	0.00127	0.019	3.0

Total population:
The calculated* total population exposure (in person-rem****) to all residents living within 50 miles of the plant site is summarized as follows:

SOURCE	1983	1984	1985	1986	1987
Maine Yankee Releases	0.003	0.009	0.033	0.039	0.019
Natural Background	50,000	51,000	52,000	53,000	54,000

The average Maine Yankee contribution to total exposure for the entire year is approximately the same as the amount received from natural sources each minute.

**Calculations based upon NRC Regulatory Guides and approved methods.*
***The nearest dwelling is in excess of 1000 meters from the Maine Yankee plant.*
****Maine Yankee license release limits mrem, whole body.*
*****Person-rem is an internationally used statistical method of exposure accounting. It is the product of the number of individuals times their exposure, e.g. if 100 persons each receives 0.1 rem of exposure, the total is 10 person-rem.*

<u>This is the most recent report available from Health and Human Services</u>
as of April, 1999

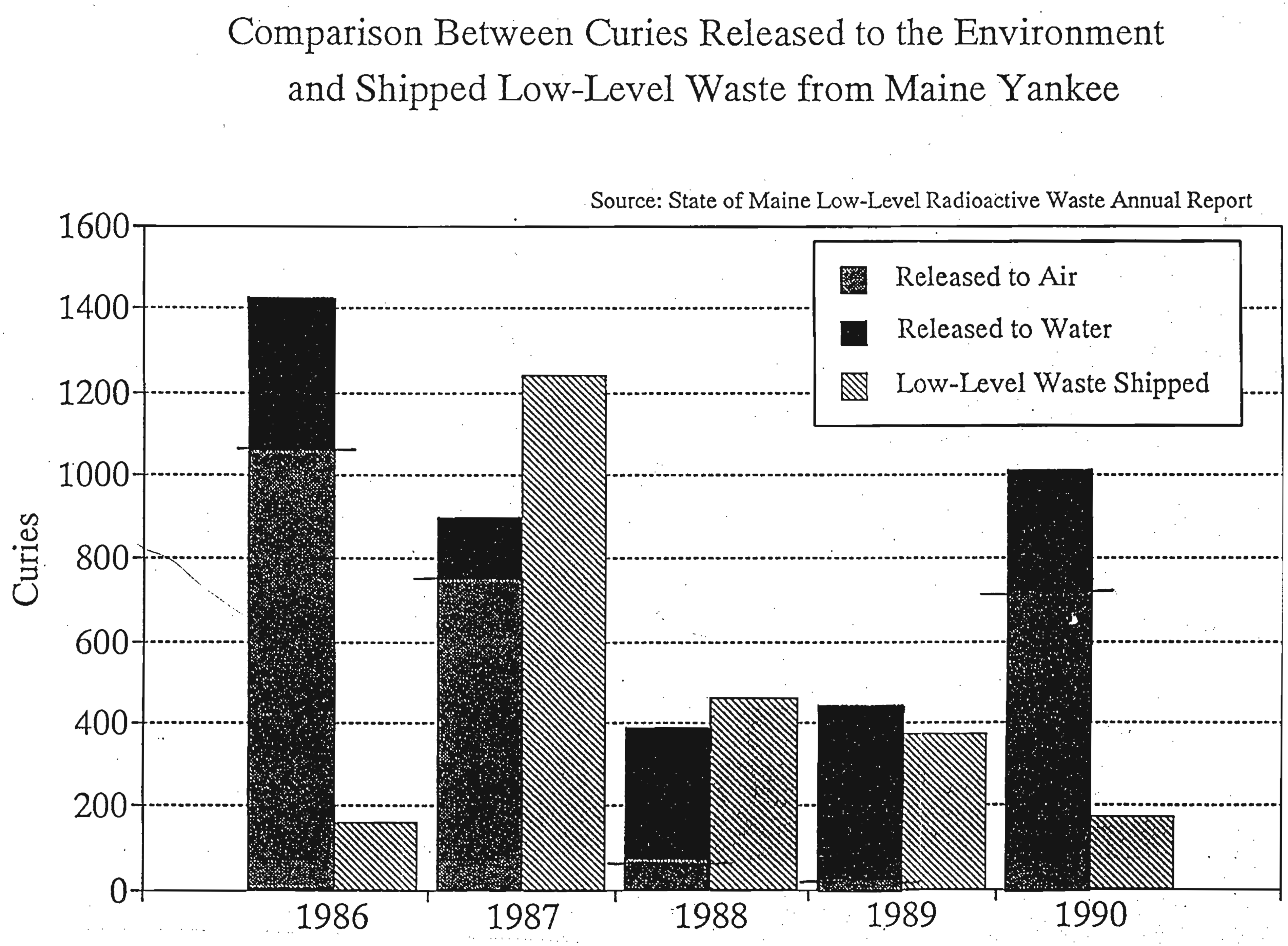


Figure IX: A Comparison of the amounts of radiation released into the environment with the amount shipped as low level waste

....Legislation was first passed by the Maine House of Representatives in 1987., and amended in January 7, 1992, by <u>H.P.1447, An Act to Require Reporting of Daily Routine Releases of Radioactive Materials</u>

This legislation requires the reporting to the public*, of

"Unscheduled releases of radioactive materials, as soon as possible, but not more than 24 hours after the discovery of the release; and

Breakdowns or malfunctions of any safety-related equipment that must be reported under the United States <u>10</u> Code of Federal Regulations, Part 21, as soon as possible, but not more than 24 hours after the discovery of the breakdown or malfunction; and

(as amended in 1992) Routine or continuous emissions of radioactive materials for every 24-hour period, within the next 24-hour period.

The total amount of radioactivity released or planned to be released. If notice is required pursuant to subsection 2, paragraph A, additional notice must be given within 24 hours after the release, describing the total amount of radioactivity actually released;

This legislationl also provides that notice of a scheduled release be followed up by notice describing the actual release within 24 hours of the release.

*this was implemented by a toll-free telephone line, (1-800-762-7104)

References:*

We can refer you in general to the Nuclear Regulatory Commission (NRC) Documents on file in the Public Document Room at the Wiscasset Library, particularly:

- The Semi-Annual Release Reports from the Maine Yankee Atomic Power Company (MYAPCO) to the NRC
- MYAPCO Annual Environmental Surveillance Reports
- Annual Reports on Radiological materials being Released From Nuclear Power Plants, prepared for the NRC by Brookhaven National Laboratory.

Also:

- Noble Gases, edited by Richard Stanley and A. Alan Moghissi, Ph.D, U.S. Environmental Protection Agency, 1973.
- Nuclear Power and its Environmental Effects, by Samuel Glasstone and Waltr H. Jordan, American Nuclear Society, La Grange Park, IL 1980
- A Radiation Monitoring System For Nuclear Power Plants, edited by Jonathan Berger, Three Mile Island Health Fund, December 1987

- The toll-free information tape at MY: 1-800-762-7104

*for a more extended reading list, send an SASE to

Citizen's Monitoring Network
40 Robinson Street
Bath, ME 04579