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Gentlemen:

Enclosed is the softcover copy of the 1987 Annual Environmental Operating Report (AEOR) for the Davis-Besse Nuclear Power Station you requested. Although the report was distributed last April, the increased demand has required a second printing. This new format - the first of its kind - is one facet of the Davis-Besse Environmental Compliance Department's effort to make the report more readable and understandable to the public. To streamline the softcover edition of the 1987 AEOR, the technical appendices, consisting almost entirely of data tables, were omitted.

For a copy of the appendices, or if you have any questions, please contact Ms. Linda S. England at (419) 249-5000, extension 7146 or Ms. Betty M. Smith at (419) 249-5000, extension 7329.

Very truly yours,

J Scott-Wasilk

JENNIFER L. SCOTT-WASILK
NUCLEAR HEALTH AND SAFETY DIRECTOR

EAD/jal

Enclosure



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# ANNUAL ENVIRONMENTAL OPERATING REPORT

JANUARY 1, 1987 - DECEMBER 31, 1987

**Environmental Compliance**

DAVIS-BESSE NUCLEAR POWER STATION®

TOLEDO EDISON

# ANNUAL ENVIRONMENTAL OPERATING REPORT

for

## DAVIS-BESSE NUCLEAR POWER STATION
## January 1, 1987 to December 31, 1987

Prepared by :

The Environmental Compliance Department
Davis-Besse Nuclear Power Station
Toledo Edison Company
Toledo, Ohio

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USFWS = United States Fish and Wildlife Service

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USFWS = United States Fish and Wildlife Service
REMP = Radiological Environmental Monitoring Program.

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USFWS = United States Fish and Wildlife Service
WSI = Weather Information Services
REMP = Radiological Environmental Monitoring Program.

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# SUMMARY

The Annual Environmental Operating Report is a detailed report on the environmental monitoring programs at Davis-Besse from January 1 through December 31, 1987. Reports on the radiological environmental monitoring, meteorlogical monitoring, marsh management, water treatment, impact assessment and environmental safety programs are included.

## Radiological Environmental Monitoring Program

The operation of a nuclear power plant may result in the release of small amounts of radioactivity to the surrounding environment. However, the quantities of such releases are small and must comply with stringent regulations imposed by the Nuclear Regulatory Commission (NRC). A Radiological Environmental Monitoring Program (REMP) has been established to monitor the radiation and radioactivity released to the environment around the Davis-Besse Nuclear Power Station. This program includes the sampling, analysis, and evaluation of the effects of these releases on the environment, as well as the evaluation of the radiation doses to individuals.

The concentrations of radiation and radioactivity are constantly being monitored around Davis-Besse within a 25 mile radius. This ensures that any detectable radioactivity present in the environment will be detected. The environment around Davis-Besse was being monitored for radiation and radioactivity for about 5 years before Davis-Besse became operational. This study provided a large amount of data on normally occurring natural background radiation and radioactivity. Davis-Besse has continued to monitor the environment by sampling air, direct radiation, well water, milk, edible meat, fruits and vegetables, soil, drinking water, surface water, fish, and lake bottom sediments. The results obtained are compared to the background concentrations present in the environment before Davis-Besse became operational. This allows us to measure the impact of the operation of Davis-Besse on the surrounding environment.

In 1987, over 2000 radiological samples were collected and over 2800 analyses for radioactivity were performed. Radionuclide concentrations measured at indicator locations were compared with concentrations measured at control locations and those measured in preoperational studies.

The 1987 operation of Davis-Besse had no significant or measurable effect on the quality of the environment. All radioactivity released in the Station's effluents was well below the applicable federal and state regulatory limits. The estimated radiation dose to the general public due to the operation of Davis-Besse was also well below all applicable regulatory limits.

The results of the Radiological Environmental Monitoring Program demonstrate the adequacy of the control of radioactive effluents at Davis-Besse. These results also demonstrate that Davis-Besse complies with all applicable federal and state regulations. The results are divided into four sections: atmospheric, direct radiation, terrestrial, and aquatic monitoring.

The atmospheric monitoring results for 1987 were similar to those of previous years. Gross beta analysis of airborne particulate samples averaged 0.02 picocuries per cubic meter ($pCi/m^3$) in 1987, which is similar to 0.05 $pCi/m^3$ in 1977-1986 (operational years) and 0.06 $pCi/m^3$ for 1972-1976 (preoperational years). Airborne radioactive iodine-131 concentrations were less than 0.7 $pCi/m^3$ in 1987 in all samples. In 1972-1976, airborne iodine-131 concentrations averaged 0.04 $pCi/m^3$, and in 1977-1986 averaged 0.16 $pCi/m^3$.

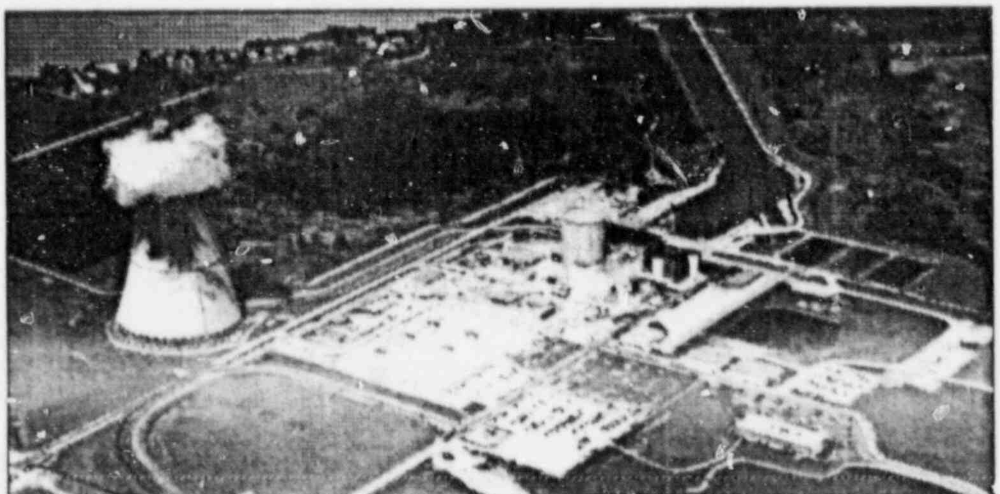


Fig. S-1: The Davis-Besse Nuclear Power Station is located on the corner of Lake Erie near Oak Harbor, Ohio. Over 700 acres of the 900 acre site are maintained as a pristine marsh.

Direct radiation measurements averaged 13.7 mr/91 days in 1987. This is almost the same as the 1972-1976 measurements (13.3 mr/91 days) and the 1977-1986 measurements (15.2 mr/91 days).

Terrestrial monitoring includes analysis of milk, well water, meat, vegetables and soil samples. The results of the sample analyses compare favorably with those of previous years. For example, iodine-131 in milk was less than 0.5 picocuries per liter in 1987. In 1977-1986 it was 3.4 picocuries per liter and in 1972-1976 was 0.97 picocuries per liter. Cesium-137 radioactivity in soil was at an average concentration of 0.48 picocuries per gram dry (pCi/g-dry) in 1987, 0.57 pCi/g-dry in 1977-1986, and 0.45 pCi/g-dry in 1972-1976. The results of the analyses of the other terrestrial samples also indicated concentrations of radioactivity comparable with previous years.

Aquatic monitoring includes the collection and analysis of drinking water, untreated surface water, fish, and lake bottom sediments. The results of the analyses indicated no detectable effects from the operation of Davis-Besse. For example, drinking water was analyzed for beta emitting radioactivity. The results averaged 1.9 picocuries per liter (pCi/l) in 1987, 2.5 pCi/l in 1977-1986, and 2.3 pCi/l in 1972-1976.

Fig. S-2: The Davis-Besse Navarre marsh area provides a home for thousands of birds like this Ruddy Turnstone

The analyses and measurement of all samples collected indicated only background concentrations of radiation and radioactivity.

The Annual Land Use Census was performed to locate all pathway locations within a five-mile radius of the station vent. The results of the census indicate that the critical receptor of the 1987 Census has not changed from the 1983, 1984, 1985 and 1986 reports. The vegetable pathway at 900 meters in the NNE sector with X/Q value of 1.19E-6 sec/$m^3$ and D/Q value of 1.39E-8 $m^{-2}$ is still the most critical receptor.

## Meteorological Monitoring

The meteorological monitoring program at Davis-Besse is part of a program for evaluating the effects of the routine operation of Davis-Besse on the surrounding environment. Meteorological monitoring began in October, 1968. Measurements are made continuously and meteorological data are monitored every day.

Meteorological data at Davis-Besse are composed of wind speed, wind direction, sigma theta (standard deviation of wind direction), ambient (outside air) temperature, differential temperature (air temperature at one height minus air temperature at another height), dew point temperature (air temperature where moisture begins to condense out of air or 100% relative humidity) and precipitation.

Fig. S-3: Davis-Besse continued to protect the marsh with the 1987 dike revetment construction project.

Two instrumented meteorological towers are used to collect data. Data recovery for 1987 was 96.71% or greater for all measured parameters. Data recovery for 1987 for the six instruments required to be operational was 99.03% or greater.

## Marsh Management

Toledo Edison and the Cleveland Electric Illuminating Company co-own the Navarre marsh which they lease to the Fish & Wildlife Service, U.S. Department of the Interior whose personnel manage it as part of the Ottawa National Wildlife Refuge. The Davis-Besse Environmental Compliance Department is responsible for the inspection of the marsh and reporting on its status monthly.

1987 projects included draining of two cattail marshes to encourage growth of new vegetation and construction of the lake front revetment to protect the barrier beach formations.

## Water Treatment

Davis-Besse uses Lake Erie as a source of water for the water treatment facility. The water is treated to make it clean and safe to drink.

Wastewater generated by site personnel is treated onsite at the Davis-Besse Wastewater Treatment facility. The wastewater is processed and then pumped to holding basins where further reduction in solid content takes place.

## Impact Assessments

Environmental Impact Assessments (EIA's) provide the means by which the integrity of Davis-Besse and its surrounding ecosystems can be maintained and enhanced. Among the EIA's performed during 1987 were the construction of a Flammable Materials Storage Building, the Administration Building Annex, and the proposed construction of a Fire Brigade Training Tower.

## Environmental Safety

The Environmental Safety section contains reports on the Hazardous Chemical Waste Management System (non-radiological), Controlled Materials Program, and Asbestos Program. Davis-Besse has developed these programs to ensure that hazardous chemical waste, controlled materials and asbestos are handled and disposed of in a safe and controlled manner.

Fig. S-4: One of the many great egrets that live in the Navarre Marsh.

RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

PHOTO: COURTESY OF USFWS

# RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

# INTRODUCTION

Coal, oil, natural gas, and hydropower have been used to run the nation's electric generating plants; however, each has its price to pay. Coal fired power plants can affect the environment through mining, acid rain, and airborne discharges. Oil and natural gas are in limited supply and are therefore costly. Hydropower is limited due to the impact of damming our waterways and only a few suitable sites are left in our country.

Nuclear energy now provides an alternate source of energy. Besides being a readily available source of energy, the operation of nuclear power plants have a very small impact on the environment. In fact, the area around the Davis-Besse Nuclear Power Station is so environmentally safe that the hundreds of acres surrounding the plant are a federal wildlife refuge.

In order for you to more fully understand this unique source of energy, background information on basic radiation characteristics, risk assessment, reactor operations, effluent control, and environmental monitoring is provided.

## Characteristics of Radiation

All matter is made of atoms, which are the smallest parts of an element that still have all the chemical properties of that element. Atoms are so small that 36 billion of them could be placed on the head of a pin. At the center of an atom is a nucleus. The nucleus consists of neutrons, with no charge and protons, with a positive charge. Electrons move in an orbit around the nucleus and are negatively charged. Normally, the parts of an atom are in a balanced or stable state. Atoms whose nuclei (plural of nucleus) contain an excess of energy are called radioactive atoms or radionuclides. Radionuclides can be naturally occurring, such as uranium-238, thorium-232 and potassium-40, or man-made, such as iodine-131, cesium-137, and cobalt-60.

Radioactive atoms attempt to reach a stable (non-radioactive) state by losing energy through a process known as radioactive decay. Radioactive decay is the release of energy from the atom through the expulsion of particles and/or electromagnetic radiation. Particulate radiation may be electrically charged such as alpha or beta particles, or be electrically neutral, such as neutrons. Radioactivity is the result of either electrically charged particulates (alpha and beta particles) or electromagnetic energy (gamma and X-rays). Alpha particles are positively charged and can be easily stopped by a sheet of paper or a few centimeters of air. Beta particles, a stream of high speed electrons, are more penetrating than alpha particles. They can usually penetrate thin metal sheets, but they cannot pass through a millimeter of lead or a few centimeters of flesh.

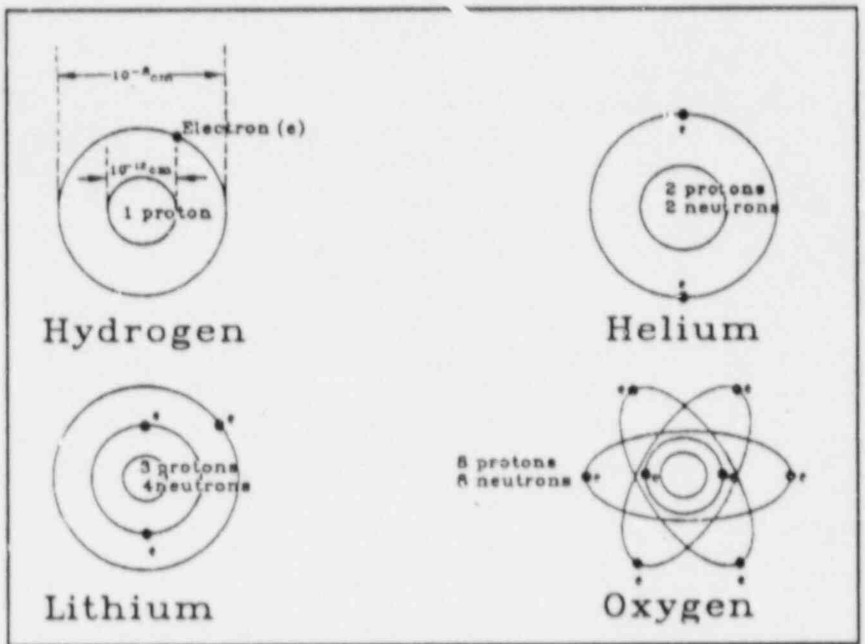


Fig.1-1: Diagrams of four common atoms.

Gamma and X-rays are electromagnetic radiation. Light is a common form of electromagnetic radiation. The primary difference between light and gamma or X-rays is the fact that gamma and X-rays are ionizing radiation. Gamma and X-rays can be stopped by shielding such as lead or concrete.

## Half-Life

A half-life is the amount of time required for a radioactive substance to lose half of its activity through the process of radioactive decay. Cobalt-60 has a half-life of about 5 years, so after 5 years 50% of its activity is gone and after 10 years 75% has decayed away. Half-lives vary from millionths of a second to millions of years.

Radioactive atoms may decay directly to a stable state or may undergo a series of decay stages and produce several daughter products which eventually lead to a stable atom. Radium-226, for example, has 10 successive daughter products (including radon) and has lead-206 as a final stable form.

## Measurements

The activity of a radionuclide is measured by a basic unit called a curie, named after Marie and Pierre Curie who discovered radium in 1898. A curie (Ci) is that amount of a radioactive material that decays at a rate of 37 billion atoms per second. In the evaluation of environmental radioactivity, a curie is an extremely large concentration of radioactivity, so smaller units of the curie are used. Two common units are the microcurie (uCi), one millionth of a curie and the picocurie (pCi), one trillionth of a curie.

A curie is a measurement of radioactivity and not quantity. The amount of some common elements necessary to produce one curie of radioactivity are listed in Table 1-1 below.

Table 1-1: One Curie of Radicactivity

| Isotope | Amount of Material |
|---|---|
| Radium-226 | 1 gram |
| Iodine-131 | 8 millionths of a gram |
| Uranium-238 | 3.3 tons |

Note: 1 pound = 454 grams

## Dose

Dose is the amount of radiation to which a person has been exposed. Total body (whole body) radiation involves the exposure of all organs. Most background exposures are of this form. Radioactive elements can enter the body through inhalation or ingestion. When they do, they are not distributed evenly. For example, radioactive iodine selectively concentrates in the thyroid gland, while radioactive cesium collects in muscle and liver tissue and radioactive strontium in mineralized bone.

The total dose to organs by a given radionuclide also depends on the quantity and the amount of time that the radionuclide remains in the body. Some radionuclides remain in the body for very short times due to their rapid radioactive decay as well as their normal elimination rate from the body, while others may remain in the body longer.

Personnel dose is normally measured by a unit of radiation called a rem. A rem is the unit of dose of any type of ionizing radiation that produces equivalent biological effects as a unit of absorbed dose of X-rays. Often a smaller unit of the rem, a millirem (mrem) is used. Milli- is a prefix used to denote 1/1000 of an item, so 1 millirem is equal to 1/1000 rem or 1000 millirems are equal to 1 rem. Generally, the term person-rem or man-rem is used to report the total dose to a population. If a population of 10,000 people each received 1 rem, the total dose to the population would be reported as 10,000 person-rems.

## Sources of Radiation

Radiation is not a new creation of the nuclear power industry, it is a natural occurrence on the earth. Mankind has always lived with radiation and always will. Every second of our lives, over 7,000 atoms undergo radioactive decay in the body of the average adult. Radioactivity exists naturally in the soil, water, air and space. All these common sources of radiation contribute to natural background

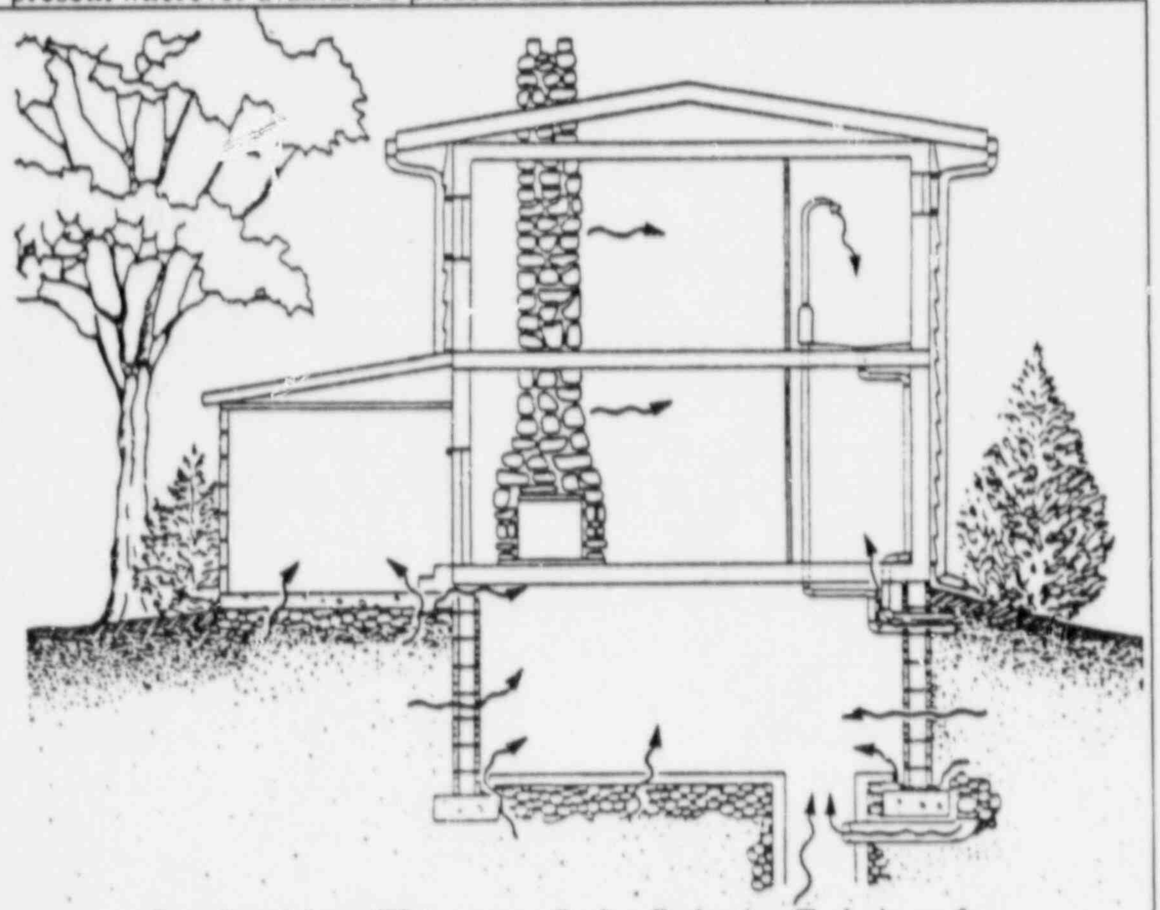
Table 1-2: Common sources of background radiation

| SOURCE | Dose (Millirem/yr.) |
|---|---|
| **Natural:** | |
| Radon | 200 |
| Cosmic Rays | 45 |
| Internal | 25 |
| Ground Sources | 27 |
| **Man Made:** | |
| Medical/Dental X-rays | 40 |
| Nuclear Medicine | 14 |
| Consumer Products | 11 |
| Weapons Fallout | 1 |
| Occupational | 1 |
| Nuclear Power | 0.4 |
| Miscellaneous | 0.4 |

radiation. Some of the common sources of background radiation and the approximate dose associated with each are given in table 1-2, based on a study by the National Council of Radiation Protection and Measurements.

The average person in the United States receives about 300 mrem (0.3 rem) per year from the natural background sources of radiation. Local factors such as geology, altitude and weather conditions can produce fluctuations in background radiation. In Colorado, for example, people receive an additional 80 mrem each year from cosmic radiation due to their high altitude and higher radioactivity naturally occurring in the soil.

Recent concern has been expressed over another source of natural background radiation - radon. Radon is an invisible gas that is naturally radioactive. It is colorless and odorless and cannot be detected by our senses. Natural radon gas is present wherever uranium is present and uranium is deposited in small amounts



Reprinted from EPA report, *Radon Reduction Techniques for Detached Houses* (EPA/625/5-86/019).

Fig. 1-2: Radon flow into and throughout a home.

throughout the earth's crust. So, natural radon gas is present in all soil, which means that everyone receives some exposure to radon gas.

Radon is found particularly in areas where slate, granite and phosphate ores abound. Other sources of radon include concrete, stone building materials, and fertilizers. When radon is outdoors in an open environment it poses almost no problems. Outside, radon is diluted and dissipated by normal wind activity.

In this age of energy efficiency, many houses are being built that are tightly sealed. This can cause radon gas to build up to high levels. Radon is produced in the soil and it can migrate through the soil and enter a house through its foundation. As shown in Fig. 1-2, radon can seep into a house through cracks, crevices, sumps and joints. Once radon enters a house it can travel throughout the house by way of the ventilation system.

Radon, a gas, naturally decays to radioactive daughter products of which some are particles like dust. These present health risks because they can be deposited in the lungs and result in tissue damage and cancer. The Environmental Protection Agency (EPA) had estimated that 5,000 to 20,000 people nationwide will die each year from naturally occurring radon which can cause lung cancer. However, a recent study by the National Council on Radiation Protection and Measurements (NCRP) indicates that the risks may be significantly higher. This study concludes that the average American receives an annual exposure equivalent to 360 millirem a year (mrem) from all sources, of which about 300 mrem a year (more than 80%) comes from nature. Previously it was estimated that natural radiation exposed Americans to 100 mrem per year.

The NCRP believes that 55% of the 360 mrem a year exposure is due to radon. About 27% is due to nature as a result of exposure to cosmic radiation from space, radiation from rocks and soil, and internal radiation from the human body. Man-made sources accounts for only 18% of the total exposure, with most of that attributable to medical procedures. The man-made sources include:

- Medical x-rays (11%)
- Nuclear medicine (4%)
- Consumer products, such as TV, smoke detectors, etc. (3%)
- Other sources, such as occupational exposure (0.3%), fallout from weapons testing (0.3%), nuclear power and nuclear fuel cycle (0.1%), and miscellaneous sources (0.1%). These other man-made sources are very small contributors to the average dose equivalent. Together they contribute less than 3 mrem/year to the average American's 360 mrem/year total exposure.

Other natural sources of radiation include drinking water which contains traces of uranium and radium, and milk which contains potassium, also a naturally occurring radioactive material.

About 300 cosmic rays from space pass through each person every second. The interaction of cosmic rays with atoms in the earth's atmosphere produces radionuclides such as beryllium-7 (Be-7), beryllium-10 (Be-10), carbon-14 (C-14), tritium (H-3), and sodium-22 (Na-22). Some of these radionuclides become deposited on land and water surfaces while the remainder stay suspended in the atmosphere.

In addition to naturally occurring radiation, people are also exposed to man-made sources of radiation. The largest of these sources is exposure from medical X-rays, fluoroscopic examinations, and radioactive drugs. These sources result in an average dose of 54 mrem a year. Small doses are caused by consumer products such as televisions, smoke alarms, and fertilizer. Very small doses result from the production of nuclear power, less than 1 millirem per year.

## Study Of Health Effects

The effects of ionizing radiation on human health have been under study for more than eighty years. Scientists have gained much valuable knowledge through the study of laboratory animals that were exposed to radiation under extremely controlled conditions. However, it has proven difficult to relate the biological effects of irradiated laboratory animals to the potential health effects of humans. Hence, much study has been done with human populations that were irradiated under various circumstances. These groups include the survivors of the atomic bomb; persons undergoing medical radiation treatment; radium dial painters, who ingested large amounts of radioactivity by "tipping" the paint brushes with their lips; uranium miners, who inhaled large amounts of radioactive dust while mining pitchblende; and early radiologists, who accumulated large doses of radiation while unaware of the potential hazards.

The studies performed on these groups have helped increase our knowledge of the health effects of large doses of radiation. To be on the conservative side, generally we assume that health effects occur proportionally to those observed following a large dose of radiation.

Radiation scientists agree that this assumption overestimates the risks associated with low level radiation exposure. The effects predicted in this manner have not been actually observed in individuals exposed to low level radiation.

Relating the effects observed due to high level exposure to the potential effects which may be caused by low level exposure is difficult to say the least. One could well state, "No one knows the risks of smoking a few cigarettes," but the risks of smoking a large number of cigarettes are well known. If 10,000 people smoke an average of four cigarettes a day, about 100 deaths will result; data are not available for lower smoking rates. For radiation, doses of 100 rem received over a short period of time to each of 10,000 people would be required to cause an equal number of deaths. The effects of acute radiation (a large dose received over a short period of time) on humans at doses of 100 rem are well known. The major controversy over radiation risks today is how to extend the risk estimates to even lower levels. As we get to lower levels, it becomes more and more difficult to detect the effects, and this becomes a problem. Finding out the effect on the death rate of one rem is about the same as trying to find out the effect of smoking one cigarette a month. The point is that the effect of one rem is extremely small. There are physical limits to how far we can go to ascertain precisely the size of the risk, but we do know it is small.

## Health Risks

Since the actual effects of low level radiation are difficult to ascertain, scientists often refer to the risk involved. The problem is one of evaluating alternatives --- of comparing risks and weighing them against benefits. Risks are a part of everyday life. The problem lies in determining how great are the risks.

We accept the inevitability of automobile accidents. Chances are that several of the people reading this report will be seriously injured this year from automobiles. By building safer cars or wearing seat belts, the risk could be reduced. But even a parked car is not risk-free. You could choose not to drive, yet pedestrians and bicyclists are also injured by cars. Reducing the risk of injury from automobiles to zero requires moving to a place where there are no automobiles.

While accepting the many daily risks of living, many people seem to be getting the idea that their demands for energy should be met on essentially a risk-free basis. Since this is impossible, attention should be focused on taking reasonable steps to safeguard the public, on developing realistic assessment of the risks, and on placing them in perspective. One of the most widely distorted risks is radiation.

Because you cannot see, feel, taste, hear, or smell radiation, it has an aura of mystery. But this is not true for other potentially hazardous things for which we have the same lack of sensory perception, such as radio waves, carbon monoxide, and small concentrations of numerous cancer-causing substances. These do not generate the same degree of fear as radiation.

To better explain the effect of radiation on people, we can compare the risk of radiation exposure with the risks associated with other life experiences. When we look at the risk of death associated with various activities, we usually look at the "one-in-a-million" risk. In other words, there is one chance in a million that each of the following activities will produce death:

- Smoking 1.5 cigarettes
- Drinking 1/2 liter of wine
- Eating 40 tablespoons of peanut butter
- Eating 100 charcoal-broiled steaks
- Traveling 300 miles in a car
- Traveling 1000 miles in a jet plane
- Having 1 chest X-ray
- Radiation dose due to living outdoors, 24 hours a day, every day, for 5 years at the site boundary of a nuclear power plant.

When compared to the risks of everyday life, the risks associated with low level radiation exposure are small.

The American Cancer Society estimates that about 30 percent of all Americans will develop cancer at some time in their lives from all possible causes. So, in a group of 10,000 people it is expected that 3,000 of them will develop cancer. If each person were to receive one additional rem of radiation, then it is expected that 3 more may develop cancer sometime during their lifetime. This increases the risks from 30 percent to 30.03%. Hence, the risks of radiation exposure are small when compared to the hazards of normal everyday life.

These comparisons should give some idea of the risk involved in activities with which you are familiar. They give a basis for judging what smoking, eating, or driving a car could mean to your health and safety. This is the kind of perspective to which people can relate. Everyone knows that life is risky. If you have the basis for judgment, you can decide what to do or not do.

# Nuclear Reactor Operation

Nuclear power plants are built to provide electricity for people. Electricity is produced by power plants using fossil fuel, uranium, or falling water. A fossil-fueled power plant burns coal, oil or natural gas in a boiler to produce heat energy. Nuclear power plants use uranium fuel and the heat produced from the fission process is used to make heat energy. In both cases, the heat boils water to produce steam which drives a turbine which turns a generator and produces electricity.

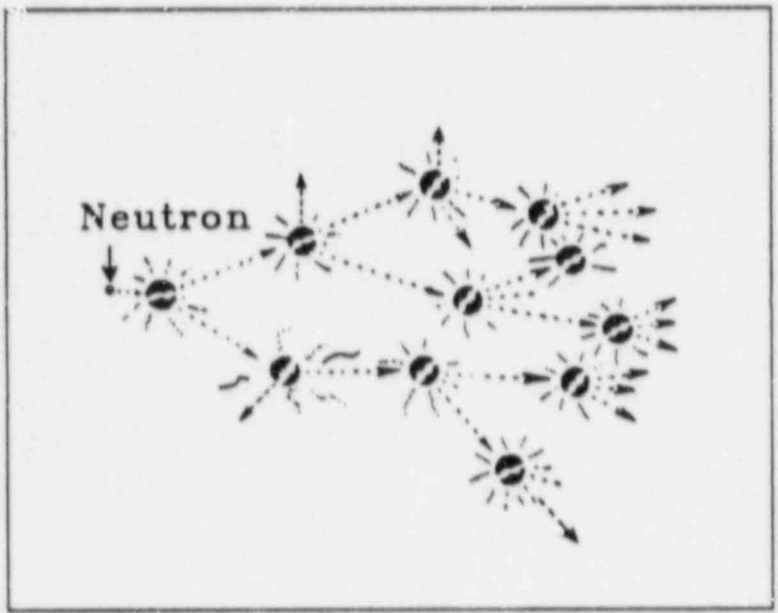


Fig.1-3: Fission: A Chain Reaction.

Nuclear energy is produced by a process called fission. Fission occurs when a heavy atom, such as uranium, is split into lighter fragments. This splitting causes heat and the release of neutrons. The neutrons strike other uranium atoms, causing them to split (fission) and release more heat and neutrons. This is called a chain reaction because it continues until stopped by insertion of the reactor control rods.

Natural uranium contains less than one percent of the isotope U-235 when it is mined. The remainder of the natural uranium is the isotope U-238. U-235 is more readily fissioned than the other, so the amount of U-235 must be increased to two or three percent for use in a pressurized water reactor (PWR) like Davis-Besse. This is done by a process called enrichment. By comparison, weapons grade uranium is enriched to over 90%.

After enrichment, the uranium fuel is chemically changed to uranium dioxide, a dry black powder. This powder is compressed and shaped into small ceramic pellets. Each pellet is about 3/4 inches long and 3/8 inches in diameter. The pellets are placed into 12 foot long metal tubes made of zirconium alloy, to make a fuel rod. About five pounds of pellets are used to fill each rod. A total of 208 fuel

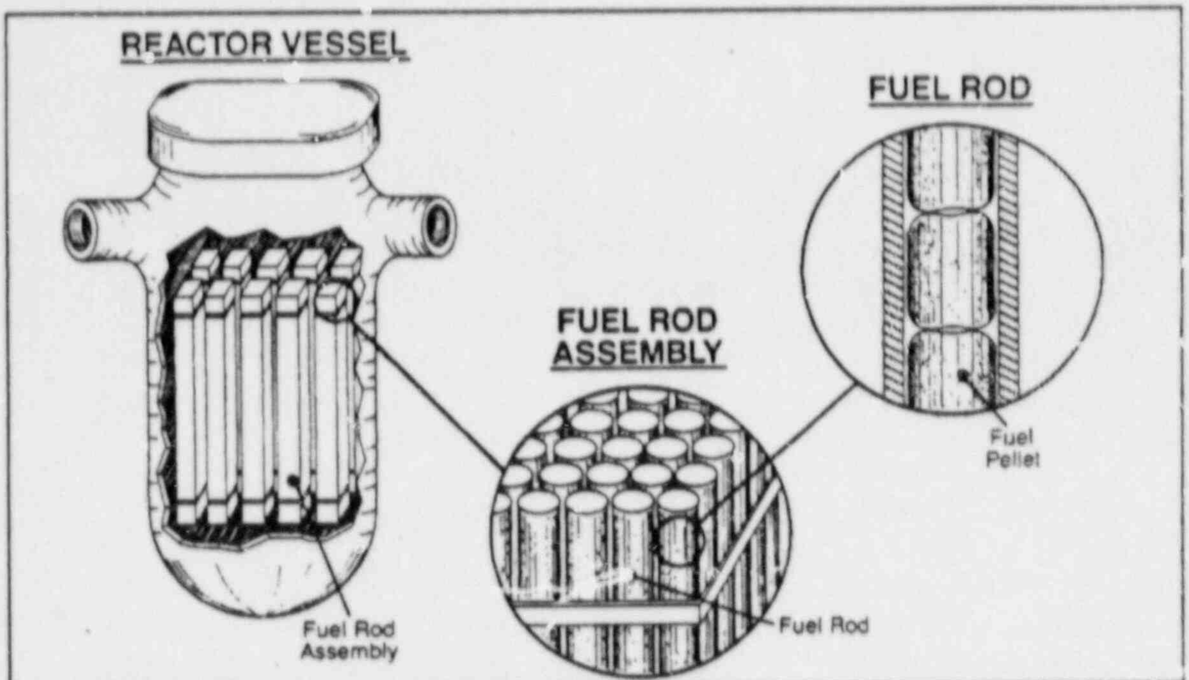



Fig.1-4: Reactor vessel with fuel assemblies, rods, and pellets.

rods make a single fuel assembly. The Davis-Besse reactor core contains 177 fuel assemblies.

Control rods are an essential part of the reactor core. Control rods contain cadmium, indium, and silver metals that absorb neutrons and control the amount of neutrons produced in the reactor. A chain reaction cannot occur when the rods are inserted completely into the core. The control rods act as brakes to slow down or stop the chain reaction. When the rods are withdrawn, the chain reaction begins and heat is once more generated.

The Davis-Besse Station uses a Pressurized Water Reactor (PWR), see Figure 1-6. The water in the reactor cooling system enters the reactor at 558°F under a pressure of 2,200 pounds-per-square inch (PSI). This pressure prevents the water in the reactor from boiling and turning into steam.

The reactor cooling water circulates continuously in a closed primary loop through the reactor and steam generators (green on Figure 1-6). The water heats to 606°F as it passes through the core. The pipes carrying this hot water pass through the steam generator which cools the water down to 558°F again. The reactor heat is transferred to a secondary loop in the steam generators (blue on Figure 1-6). The reactor cooling water (primary coolant) is prevented from coming in direct contact with the water in the secondary loop by tubes in the steam generators. The water in the secondary loop boils to steam in the steam

steam generators. The water in the secondary loop boils to steam in the steam generator and the steam (red on Figure 1-6) flows to the turbine generator where its energy is converted to electricity.

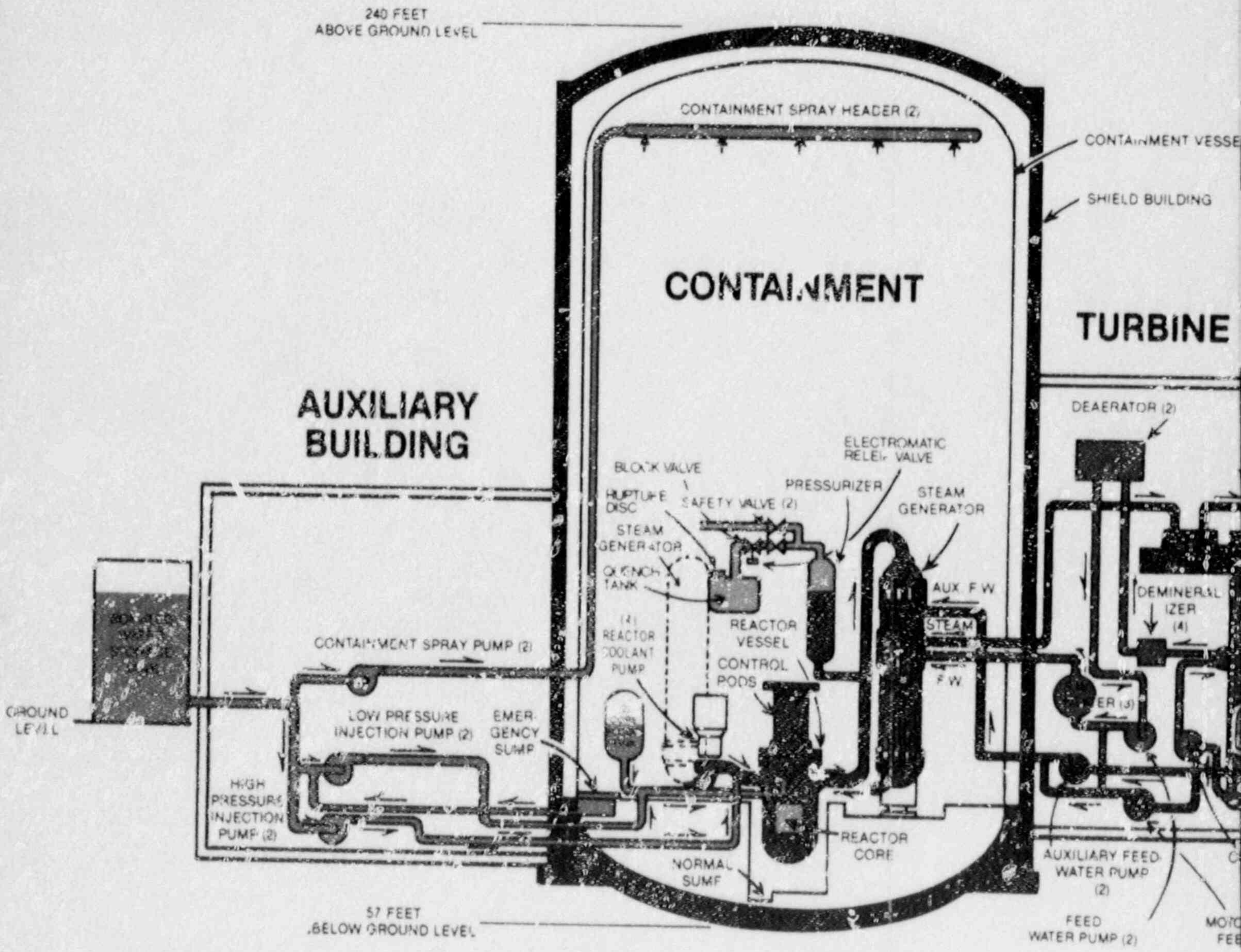
From the point that the steam leaves the reactor building, the nuclear plant closely resembles any other steam powered generating plant. Steam from the steam generator drives the turbine-generator and is then condensed. It is cooled to a liquid form by transferring its heat to a third closed loop system called the circulating water system (yellow on Figure 1-6). Water in this system carries heat from the condenser to the cooling tower where heat is lost to the atmosphere. This water is completely separated from any water which is potentially radioactive. The water is recirculated back to the condenser to cool more steam.

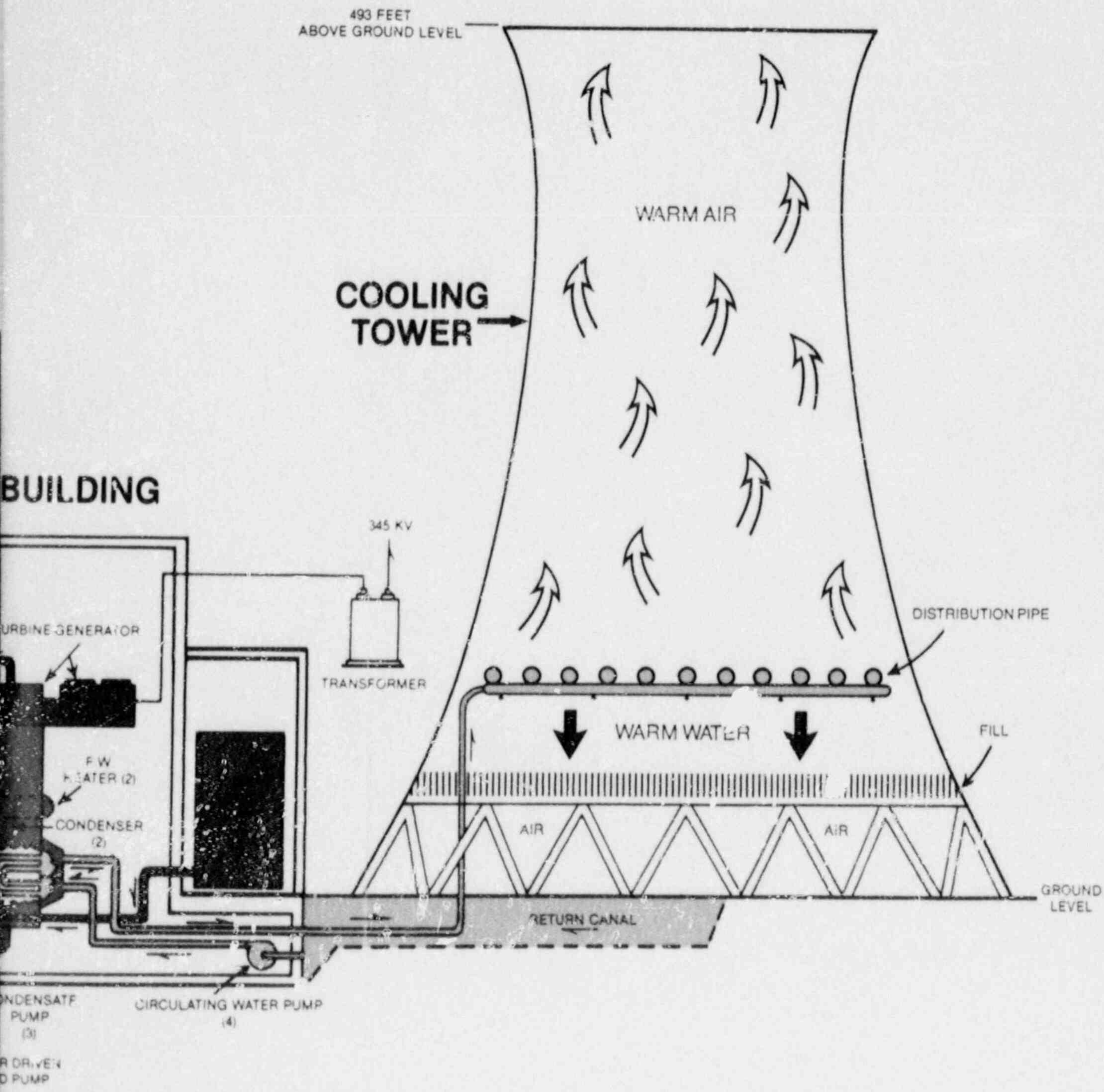
The cooling tower is probably one of the most distinctive features at Davis-Besse. Like all others, the one at Davis-Besse is used to remove excess heat from the plant so the amount of warm water discharged to Lake Erie is minimized and to cool the water to acceptable levels for condenser efficiency. Such towers are also found at some new coal-fired plants.

Fig. 1-5: The Cooling tower releases clean water in the form of vapor.

The cooling tower structure is actually a chimney designed to create a natural draft, just like the chimney in a fireplace. It is open at the bottom to let air in. Above this are sheets of fill material, arranged so that air can flow past. Warmed water is showered down onto the fill and is cooled to about 60°F (or lower) by the draft of air passing up through the chimney. This cooled water falls into a pool at the bottom of the tower and is returned to the condenser to be used again. This water does not mix with the reactor water and therefore no radioactivity is added to it from the operation of the plant. Both the primary and secondary cooling systems are contained within separate closed piping systems. The vapor discharged from the cooling tower into the atmosphere is just plain water.

Fig. 1-6: Davis-Besse Nuclear Power Station, Unit No. 1



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## Containment of Radioactivity

Essentially all the radioactivity of an operating nuclear power plant is contained by a system of isolation barriers. They prevent the escape of radioactivity to the environment.

The first barrier is provided by the ceramic fuel pellets. They contain the fuel and most of the fission products produced. Only those fission products that are volatile and gaseous at normal operating temperature are able to migrate out.

The pellets are contained in the second barrier, the fuel rods. They also prevent the escape of radioactivity. There is a small gap between the fuel and the metal container in which noble gases and other volatile nuclides can collect.

The third barrier is the primary coolant. Many of the fission products, including radioactive iodines and strontiums, are water soluble and are retained in the primary coolant. These nuclides can be removed by the processing system (demineralizers) of the reactor. The noble gases, such as radioactive kryptons and xenons, do not readily dissolve but evolve into a gas or vapor phase above the coolant, especially when the coolant is depressurized.

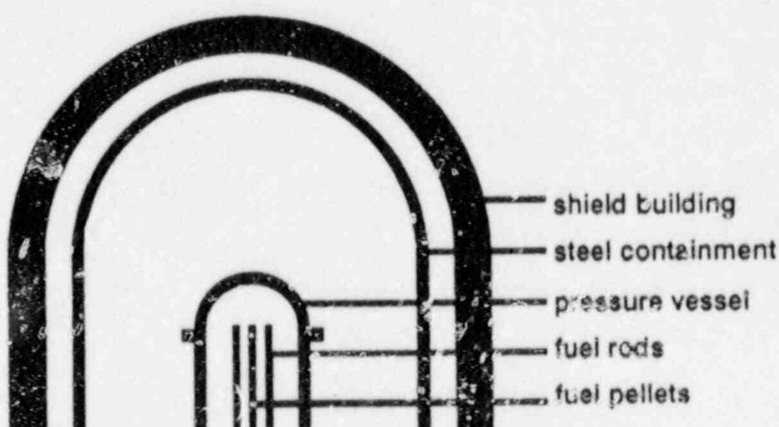



Fig. 1-7: Barriers against the release of radiation and radioactivity.

The steel reactor pressure vessel, with walls that are 8 1/2 inches thick, and the steel piping of the primary coolant system provide a fourth barrier. They contain the radionuclides in the primary coolant.

The shield building provides the final barrier. This is the dome shaped building seen in the the middle of the plant site (see Figures 1-5, 1-6 and 1-7). The containment building has thick, steel lined, reinforced concrete walls (2 1/2 feet thick) to enclose the primary coolant system and provides additional defense against any uncontrolled release of radioactivity to the environment.

All these barriers combine to protect the public and the environment from an uncontrolled discharge of radioactivity and radiation.

## Reactor Safety

Nuclear power plants are inherently safe, not only by the laws of physics, but by design. Nuclear power plants cannot explode like a bomb because the concentration of fissionable material is far less than is necessary for such a nuclear explosion. Just as the battery of a flashlight provides enough energy to produce light, the amount of energy is far below the amount needed to electrocute a person. Many safety features with several backup systems are provided to assure that any possible accident would be prevented from causing a serious health or safety threat to the public.

The Davis-Besse reactor, like all U.S. nuclear units, has many overlapping safety features, called redundant devices. If one system should fail, there would still be back-up systems to assure the safe operation of the plant.

During normal operation, the reactor control system regulates the power output by adjusting the position of the control rods which absorb neutrons. The reactor can be automatically shut down by a separate reactor protection system that causes all the control rods to be quickly and completely inserted into the reactor core, stopping all chain reactions. The control room is located away from the reactor and would be safe to occupy during most conceivable accidents.

To guard against the possibility of a loss of reactor cooling water, the reactor system is equipped with an emergency core cooling system designed to pump reserve water into the reactor automatically if the reactor coolant pressure drops below a predetermined level.

# Description of the Davis-Besse Nuclear Power Station Site

The Davis-Besse site is located in Carroll Township of Ottawa County, Ohio. It is on the southwestern shore of Lake Erie just north of the mouth of the Toussaint River. The site lies north and east of Ohio State Route 2, approximately 10 miles northwest of Port Clinton, 7 miles north of Oak Harbor, and 25 miles east of Toledo, Ohio.

This section of Ohio is flat and marshy, with maximum elevations of only a few feet above lake level. The area was originally swamp forest and marshland, rich in wildlife but useless for settling and farming. During the nineteenth century, the land was cleared and drained, and has been farmed successfully since. Today, the terrain consists of farmland with marshes extending in some places for up to 2 miles inland from the Sandusky Lake Shore Ridge.

Fig. 1-8: Hundreds of geese live right at Davis-Besse.

More than half the Davis-Besse site area is marshland; the farmland portion of the site is small. The marshes are part of a valuable ecological resource, providing a breeding ground for a variety of wildlife and a refuge for migratory birds. Major species of birds using this portion of the Lake Erie marshes include mallards, black ducks, wigeon, egrets, great blue herons, blue-winged teal, and Canada geese. In fact, there are hundreds of geese living right on the site. Bald eagles, ospreys, swans, great horned owls, and a large number of hawks are often seen in the area.

The site includes a tract known as Navarre Marsh, which was acquired from the U.S. Bureau of Sport Fisheries and Wildlife, Department of the Interior. In 1971, Toledo Edison purchased the 188 acre Toussaint River Marsh. The Toussaint River Marsh is contiguous with the 610-acre Navarre Marsh unit of the Ottawa National Wildlife Refuge.

Most of the remaining marsh has been maintained by private hunting clubs, the U.S. Fish and Wildlife Service, and the Ohio Department of Natural Resources Division of Wildlife. There are some residences along the lake shore used mainly as summer houses. However, the major resort area of the county is farther east, around Port Clinton, Sandusky, and the group of islands known as the Bass Islands

The immediate area near Davis-Besse is sparsely populated; Ottawa County had a population of only 40,076 in a 1980 census. The nearest incorporated communities are:

- Port Clinton - 10 miles southeast, population 7,223
- Oak Harbor - 7 miles south, population 2,678
- Rocky Ridge - 7 miles west southwest, population 457

Toledo is the nearest major city, about 25 miles west of Davis-Besse, and has a population of about 354,650.

The non-marsh areas around the Davis-Besse site are used primarily for farming. The major crops include soybeans, wheat, oats, hay, fruit and vegetables. Livestock raising and dairy farms are not major activities.

The main industries within 5 miles of the site are located in Erie Industrial Park, about 4 miles southeast of the site.

The State of Ohio, Department of Natural Resources, operates many wildlife and recreational areas within 10 miles of the site. These include Magee Marsh, Turtle Creek, Crane Creek State Park, and the Ottawa National Wildlife Refuge. Magee Marsh and Turtle Creek lie between 3 and 6 miles west-northwest of the site. Magee Marsh is a wildlife preserve with the public being admitted for fishing, nature study, and controlled hunting in season. Turtle Creek, a wooded area at the southern end of Magee Marsh, offers boating and fishing. Crane Creek State Park is adjacent to Magee Marsh and is a popular picnicking, swimming, and fishing area. The Ottawa National Wildlife Refuge lies 4 to 9 miles west-northwest of the site, immediately west of Magee Marsh.

The radiological characteristics of the area surrounding Davis-Besse are not unusual. Natural and man-made background radiation in the area are typical for

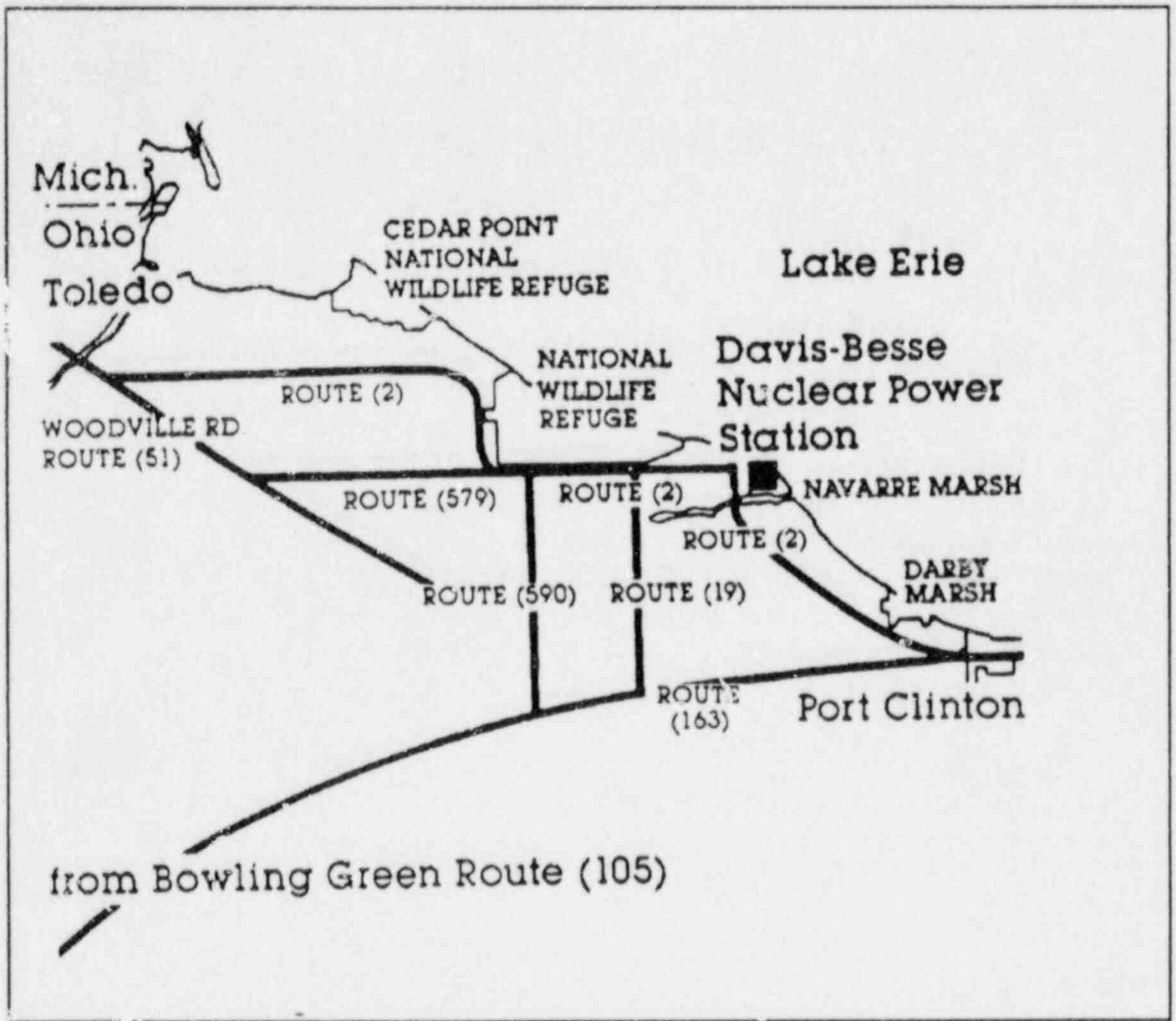



Fig. 1-9: Map of the Davis-Besse area.

Midwestern states. Radiological monitoring stations have been active in the area since 1960, so that a considerable amount of background data is available. These stations have monitored not only Lake Erie, but also surface, ground, and tap water in the area, as well as milk, dietary and atmospheric concentrations. Through comparison with this extensive background data, the change in radiation due to the operation of Davis-Besse has been shown to be minimal.

# The 1987 Radioactive Liquid and Gaseous Effluents Summary

## Sources

Through the normal operations of a nuclear power plant, most of the fission products are retained within the fuel and fuel cladding. However, small amounts of radioactive fission products do migrate into the primary coolant (green on Figure 1-6). Additionally, trace amounts of the component and structure surfaces, which have been activated, also get into the primary coolant water. Many of these particles are removed through demineralizers in a processing system for the primary coolant. Small releases of radioactive liquids may occur from valves, piping or equipment associated with the primary coolant system. These liquids are collected through a series of floor and equipment drains and sumps. All liquids of this nature are processed and carefully monitored prior to release.

The noble gas fission products, which are not very soluble in the primary coolant and cannot be removed by demineralizers, are given off as a gas when the primary coolant is depressurized. These gases are then collected by a system designed for gas collection and storage.

## Protection Standards

Soon after the discovery of X-rays in 1895 by Wilhelm Roentgen, the potential hazards of ionizing radiation were recognized and efforts were made to establish radiation protection standards.

The International Commission on Radiological Protection (ICRP) was established in 1928. In 1929, the National Council on Radiation Protection and Measurements (NCRP) was formed. These two groups have the longest continuous experience in the review of radiation health effects and with recommendations on guidelines for radiological protection and radiation exposure limits.

These committees and many others are dedicated to understanding the health effects of radiation by investigating all sources of relevant information and by providing guidance for radiological protection. The U.S. Nuclear Regulatory

Commission (NRC) has depended upon the recommendations of these organizations for basic radiation protection standards and guidance in establishing regulations for the nuclear industry.

The recommendation of the ICRP and NCRP is that radiation dose should be maintained as low as reasonably achievable (ALARA).

## Limits

The U.S. Nuclear Regulatory Commission (NRC) requires nuclear power plants to be designed, constructed and operated to keep the levels of radioactive material in effluent releases to unrestricted areas as low as reasonably achievable or ALARA. To assure these criteria are met, each license authorizing nuclear reactor operation includes Technical Specifications governing the release of radioactive effluents (Code of Federal Regulations, Title 10, Part 50, Appendix I). The Technical Specifications specify the limits for the release of radioactive effluents, as well as the limits for doses to the general public from the release of radioactive liquid and gaseous effluents. These limits are set well below the ICRP, NCRP, and NRC guidelines, so keeping releases within these operating guidelines is a demonstration that radioactive effluents are being maintained as low as is reasonably achievable.

For determining the impact of radioactive effluents on human health and the environment, all possible pathways are included in determining radiation exposure doses. To protect the general public, federal regulations, as defined by 10 CFR 20 and 10 CFR 50, establish limits on the concentrations of radioactive effluents released to unrestricted areas. Federal regulations also specify the need for making every reasonable effort to keep radioactive releases as far below the specified limits as is reasonably achievable. To meet these federal criteria, Davis-Besse, like all nuclear plants, has restrictions on its calculated release limits.

The dose to a member of the general public from radioactive material in liquid effluents released to unrestricted areas is limited to:

- Less than or equal to 3 mrem per year to the total body.

  - and -

- Less than or equal to 10 mrem per year to any organ.

The air dose due to release of noble gases in gaseous effluents is restricted to:

- Less than or equal to 10 mrad per year for gamma radiation.

  - and -

- Less than or equal to 20 mrad per year for beta radiation.

The dose to a member of the general public from iodine-131, tritium, and all particulate radionuclides with a half-life greater than 8 days in gaseous effluents is limited to:

- Less than or equal to 15 mrem per year to any organ.

These ALARA guidelines are a fraction of the dose limits established by the Environmental Protection Agency (EPA). In its Environmental Dose Standard of 40 CFR 190, the EPA established dose limits in the vicinity of a nuclear power plant. These dose limits are:

- Less than or equal to 25 mrem per year to the total body
- Less than or equal to 75 mrem per year to the thyroid

  - and -

- Less than or equal to 25 mrem per year to any other organ.

## Processing and Monitoring

Effluents are strictly controlled to ensure radioactivity released to the environment is minimal and does not exceed release limits. Effluent control includes the operation of radiation measuring systems, an in-plant and offsite environmental sampling and analysis program, a quality assurance program for effluents and environmental samples, and procedures covering all aspects of effluent, and environmental monitoring.

The waste treatment systems at Davis-Besse are designed to collect and process the liquid and gaseous wastes which contain radioactive material. The plant's radioactive waste systems provide for the storage, clean up, and recycling of liquid and gaseous wastes. For example, the Waste Gas Decay tanks are holding tanks which allow radioactivity in gas to decay prior to release to the station vent. Wastes are sampled prior to release and are reprocessed, if required.

Monitoring of radioactive releases starts at the plant. In-plant monitoring systems are used to ensure any radioactive material released is below the regulatory limit. Liquid and gaseous effluent measuring equipment is designed to detect the presence and the amount of radioactivity in liquid and airborne effluents. The instruments provide a continuous indication of any radioactivity present. The instruments are sensitive enough to measure 100 to 1000 times lower than the release limits. Each instrument is equipped with alarms which are connected to the Control Room. The alarm setpoints are set low to ensure effluent release limits will not be exceeded. If alarm setpoints are reached, liquid and gaseous releases are automatically stopped.

In addition to continuous radiation monitoring instruments, effluent samples are collected and analyzed in the laboratory to identify the specific radionuclide quantities being released. Sampling and analysis provides a more sensitive and precise method of determining effluent composition than with instruments alone. Samples are analyzed using the highest quality counting equipment. Instrument readings and sample results are compared to ensure correct correlation.

A system of radiation monitors at the discharge points of all liquid and gaseous effluent releases are used for assessing the releases and their environmental impact. Once released, the dispersion of radionuclides in the environment is easily determined by computer modeling. Gaseous releases are carried away from the site by atmospheric diffusion which continually acts to disperse the radioactivity. Atmospheric dispersion includes factors such as wind speed, atmospheric stability, terrain (flat or hilly) and changes in the wind direction. A weather tower is located in the southwest sector of the station. It is linked to a computer which permanently records all necessary meteorological data (see Meteorological Monitoring section). Computer models are also used to predict the down-stream dispersion and travel time for liquid releases. In addition to predicting the distribution of radionuclides in the environment from each release, computer modeling provides accurate estimates of radiation doses to humans and the environment. For normal plant operation, computer modeling provides a reference against which actual environmental sampling and measurements are compared.

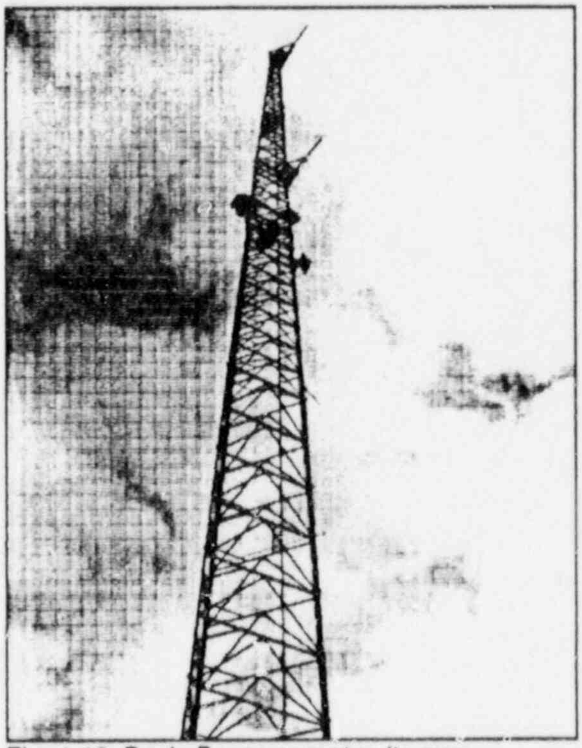


Fig. 1-10: Davis-Besse operates its own weather station. The main weather tower (shown here) is 100 meters tall and has 3 levels of sensors.

Beyond the plant itself, the radiological environmental monitoring program continuously tests for the presence and possible build-up of radionuclides in the environment which may result in external and internal radiation exposures. Radiation exposure may be either internal or external depending on whether the source of radiation is within or outside the body.

## Exposure Pathways

Radiological exposure pathways are the methods by which people may become exposed to radionuclides released from nuclear facilities. The major pathways of concern are those which could cause an appreciable radiation dose. The major pathways are determined based upon the type and amount of radioactivity released, the environmental transport mechanism, and our use of the

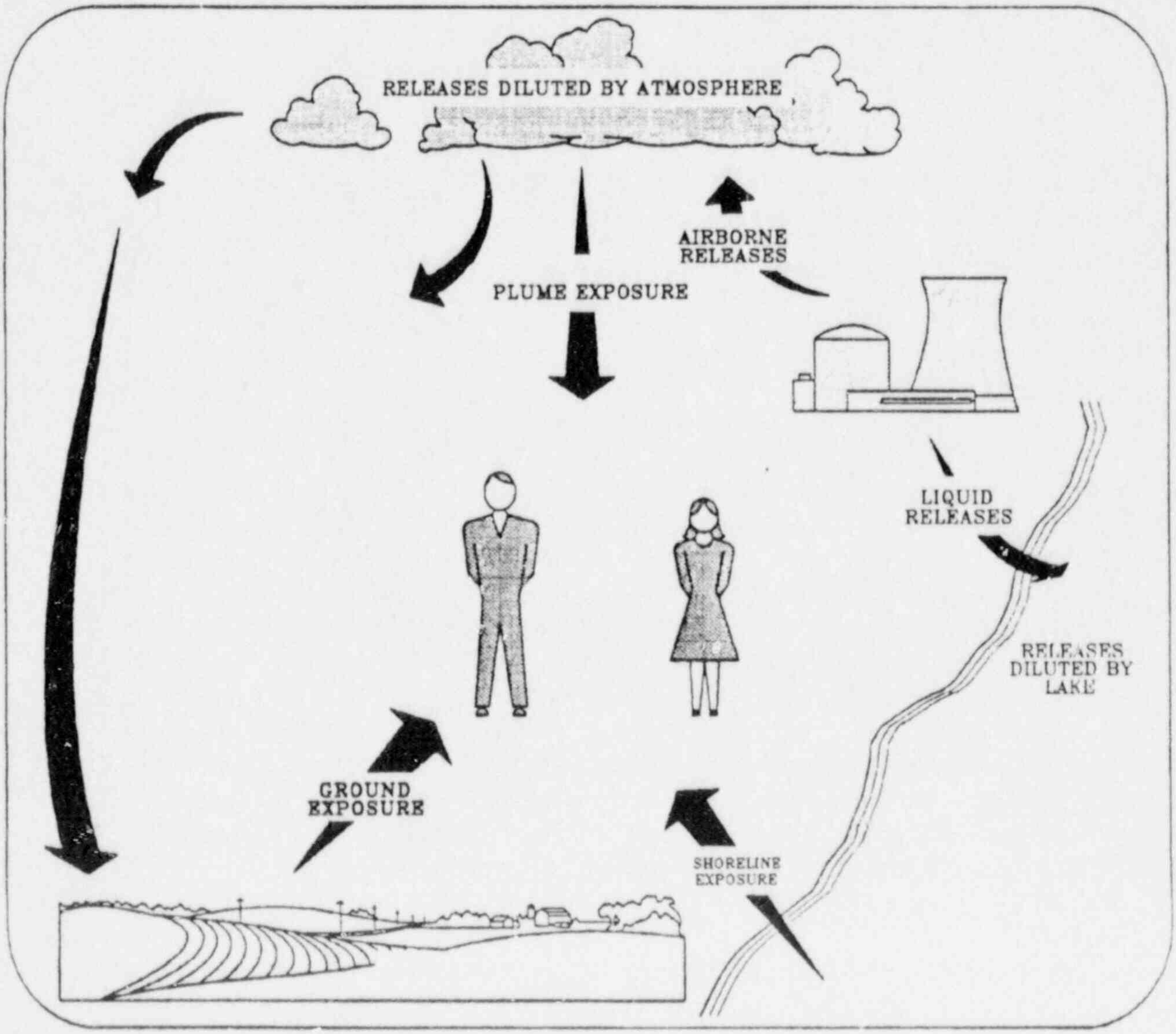



Fig. 1-11: External environmental exposure pathways.

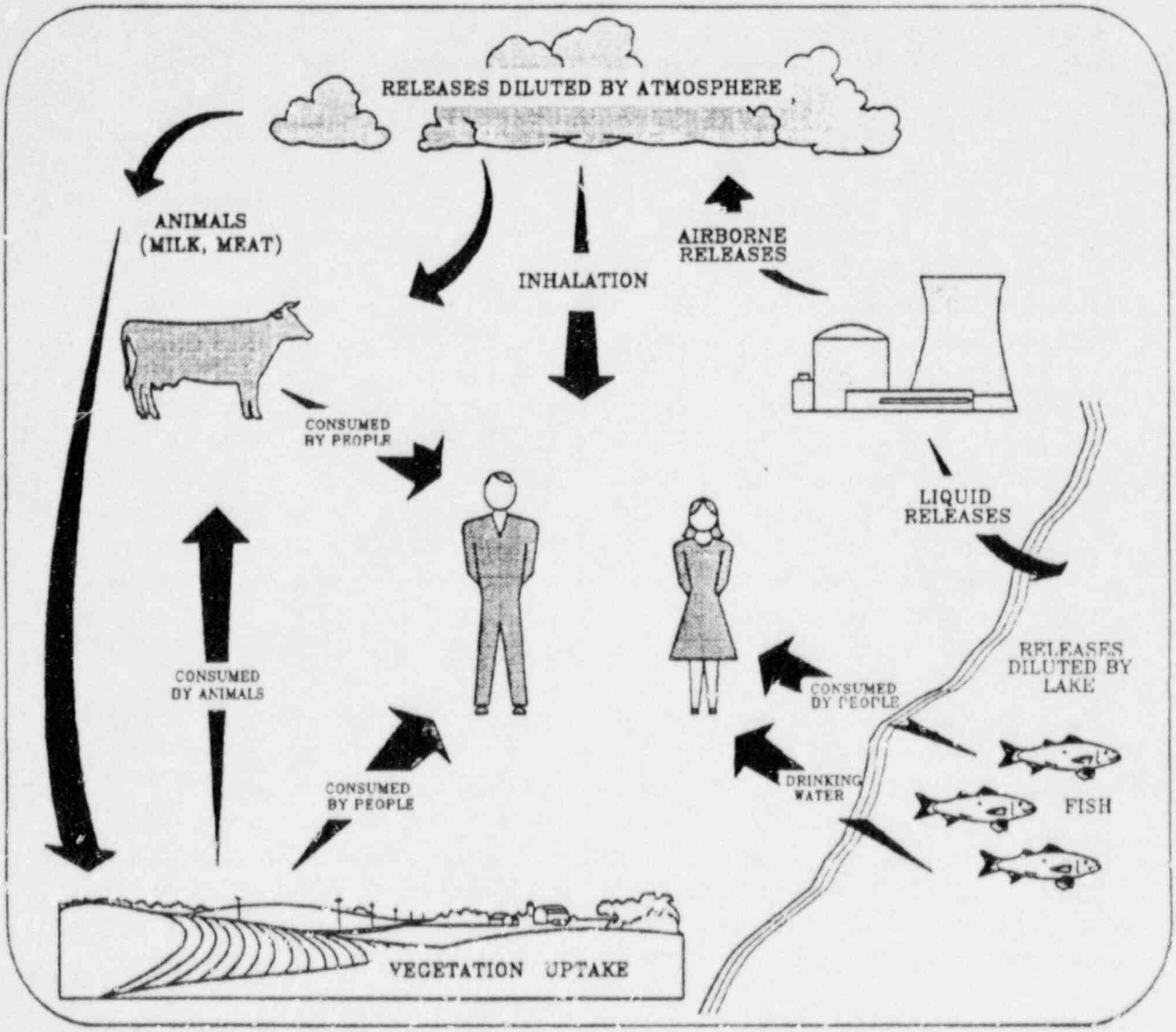



Fig. 1-12: Internal environmental exposure pathways.

environment. The type and amount of radioactivity released is carefully measured at Davis-Besse. These measurements include analysis of the physical and chemical nature of the radionuclides and are used to determine how the radionuclides will interact with the environment. The environmental transport mechanism includes consideration of physical factors, such as the hydrological (water) and meteorological (weather) characteristics of the area. This provides information on the water flow, wind speed and wind direction at the time of the release which is used to evaluate how the radionuclides will be distributed in the area. The most important factor in evaluating the exposure pathways is the use of the environment. Many factors are considered such as dietary intake of residents in the area, recreational use of the area, and the location of homes.

The environmental pathways considered are shown in Figure 1-11 and Figure 1-12. The radioactive gaseous effluent exposure pathways include direct radiation, deposition on plants, deposition on soil, inhalation by animals and inhalation by humans. The radioactive liquid effluent exposure pathways include drinking water, fish consumption and direct exposure from the lake.

Each of the possible routes that can lead to radiation exposure to humans is called an exposure pathway. As you can see in Figures 1-11 and 1-12, these routes are both numerous and varied. In some cases, they are relatively simple, such as inhalation of airborne radioactive materials. In other cases these routes may be complex multistep processes. For example, airborne radioactive particulates can be deposited onto forage which is then eaten by a cow, a portion of the material ingested by the cow may be secreted into the milk, which is consumed by man (Figure 1-12). This is called the air-grass-cow-milk pathway.

Although radionuclides can reach humans by many different pathways, some are more important than others. The concern is the critical pathway, which is defined as the exposure pathway that will provide, for a given radionuclide, the greatest dose to a population, or to a specific segment of the population. This segment is called the critical group, and may differ depending on the radionuclides involved, age, diet, or other cultural factors. The dose may be delivered to the whole body or to a specific organ. The organ receiving the greatest fraction of the permissible dose level is called the critical organ.

Fig. 1-13: Davis-Besse personnel monitor all exposure pathways with a vast array of sensitive instruments.

# Dose Assessment

The radiation doses to people in the area surrounding Davis-Besse are calculated for each release using the concentrations of radioactive material in each release and the weather conditions present at the time of the releases. The doses are calculated in the predominant wind direction and take into account the location of the nearest residence, vegetable gardens, and milk animals. The doses calculated also use the concepts of a "maximum exposed individual" and "standard man," and maximum use factors for the environment. These are factors such as how much milk a person drinks per year, how long a person stays outdoors, and how much air a person breathes per year. The use of these guidelines results in a very conservative overestimation of the radiation dose to people.

# Results

The results of the liquid and gaseous effluent monitoring program are reported semiannually to the NRC. In 1987, the doses (whole body and organ) from radioactive releases were a small fraction of the NRC limits. The doses due to liquid releases were less than 5 percent of the NRC limits and the doses due to gaseous releases were even smaller, less than 0.2 percent of the NRC limits. Table 1-3 presents a comparison of the doses from the 1987 radioactive effluent releases and the regulatory limits.

A review of effluent monitoring data from 1977 through 1987 shows that controlled liquid and gaseous releases resulting from normal operations and activities at Davis-Besse did not exceed federal release limits and the maximum exposure doses were small fractions of the regulatory exposure limits.

Radioactivity releases from Davis-Besse and other nuclear power plants contribute a very small percentage increase to the radioactivity that has always been present in the air, water, soil, and even our bodies. The small radiation doses resulting from Davis-Besse's effluent releases can be viewed in perspective when it is recognized that in any given year each person in the United States receives about 300 mrems from natural background radiation.

Figures 1-14 and 1-15 present a comparison of the NRC guidelines and the results of monitoring at Davis-Besse since 1978, these graphs show that Davis-Besse has maintained doses far below the applicable regulatory limits since it began operation, from both gaseous and liquid releases.

# Noble Gas

Some of the radionuclides released in airborne effluents are radioactive isotopes of the noble gases such as xenon and krypton. Noble gases are biologically and chemically nonreactive. They do not concentrate in humans or other organisms. They contribute to human radiation exposure by being a source of external whole

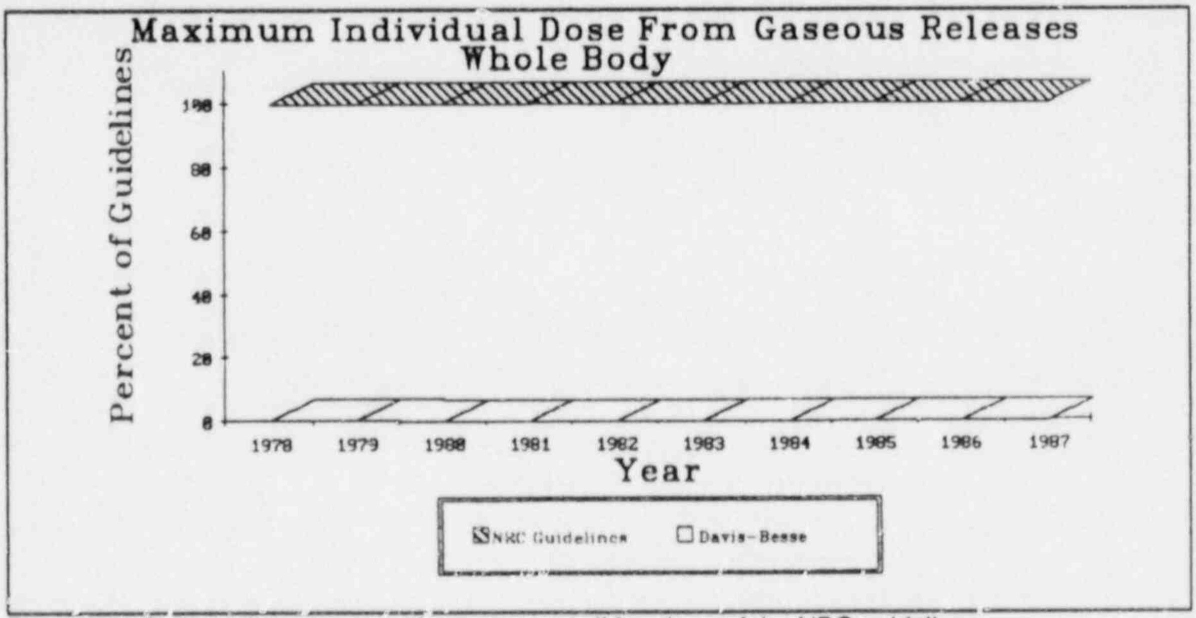



Fig. 1-14: Radioactive gaseous releases are small fractions of the NRC guidelines.

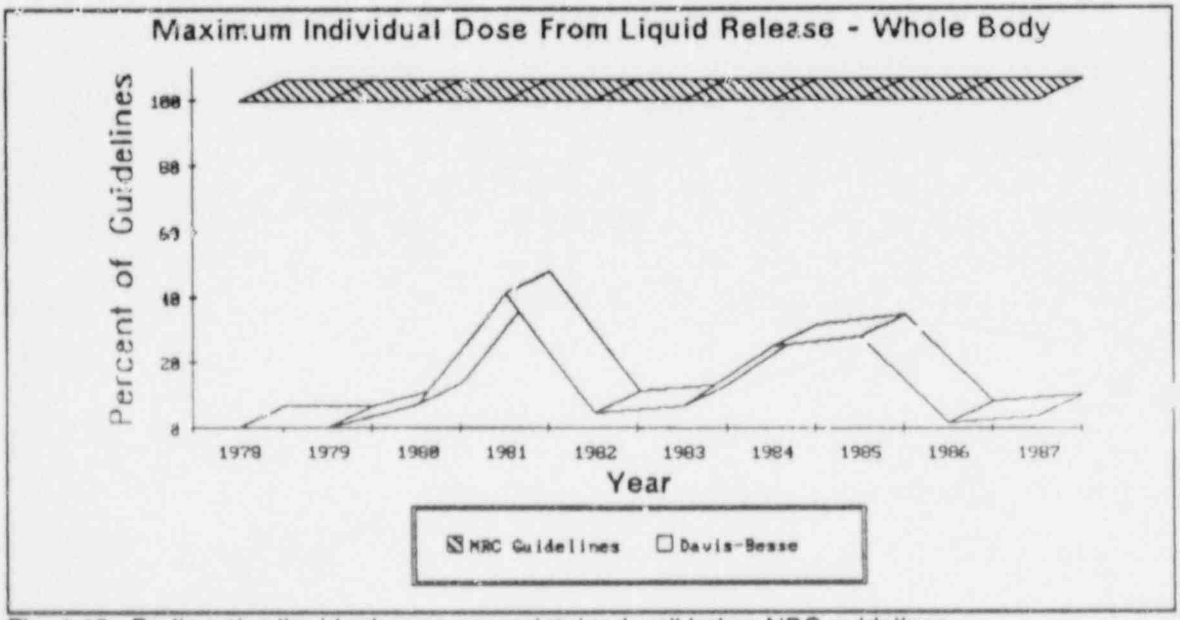



Fig. 1-15: Radioactive liquid releases are maintained well below NRC guidelines.

Table 1-3

## DOSE DUE TO 1987 RADIOACTIVE EFFLUENT RELEASES

### Liquid Effluents

| Type | 1987 Dose (mrem/yr) | NRC Limit (mrem/yr) | Percent of NRC Limit |
|---|---|---|---|
| Total Body | 0.13 | 3 | 4.3 |
| Any Organ | 0.18 | 10 | 1.8 |

### Gaseous Effluents

| Type | 1987 Dose (mrem/yr) | NRC Limit (mrem/yr) | Percent of NRC Limit (mrem/yr) |
|---|---|---|---|
| Noble Gas (Gamma) | 0.008 | 10 | 0.08 |
| Noble Gas (Beta) | 0.023 | 20 | 0.12 |
| I-131, Tritium and Particulate Radionuclides with half-lives greater than 8 days. | 0.024 | 15 (any organ) | 0.16 |

body exposure. Xenon-133 and xenon-135 with half-lives of 5 days and 9 hours, respectively, are the major noble gases released. They are readily dispersed in the atmosphere when released and because of short half-lives quickly decay into stable forms. Smaller amounts of krypton-85 (10.8 year half-life) are also released. The longer half-life of this radionuclide makes it more persistent in the atmosphere. However, nuclear power production is only a small contributor to the total atmospheric inventory of krypton-85 and has not caused measurable increases in background concentrations. During the operation of Davis-Besse (1977 through present), the maximum amount of noble gas released was 1012 curies in 1981. This was well below federal effluent limits. In 1987, the total amount of noble gases released was 380 curies which represents 0.08% of the gamma dose limits and 0.12% of the beta dose limits (see Table 1-3).

## Iodines and Particulates

Annual releases of radioactive iodines and particulates in airborne and liquid effluents released to the environment are small. Factors such as their high chemical activity and solubility in water, combined with the high efficiency of airborne and liquid processing systems minimize the discharge of radioactive iodines and particulates to the environment. Iodine-131 (8 day half-life) is the predominant radioactive iodine released.

The principal particulates released are radioactive cesiums (Cs-134 and Cs-137) and activation products (cobalt-58 and cobalt-60). The maximum amount of radioactive iodines and particulates released from Davis-Besse in a year was 0.054 curies in airborne effluents and 1.33 curies in liquid effluents, both in 1981. In 1987, the amount of radioactive iodines and particulates released was 0.001 curies in gaseous effluents and 1.16 curies in liquid effluents. These releases were well below federal effluent limits.

## Tritium

Tritium is the predominant radionuclide released in liquid effluents and also is released in gaseous effluents. Tritium is a radioactive isotope of hydrogen. It is produced in the reactor coolant as a result of neutron interaction with naturally occurring deuterium (also a hydrogen isotope) present in water and with the boron used for reactivity control of the reactor. The amount of tritium released was 246 curies in 1987. This is less than 1 percent of the federal effluent limits. All releases of tritium in liquids (1977 to the present) have been substantially below the federal effluent limits. Since tritium is a low energy beta emitter and therefore of low dose consequence, the radioactivity concentration guides issued by the ICRP, NCRP, and other standard setting organizations is higher for tritium than for most other radionuclides. Because of the large abundance of tritium already in the environment much larger releases of tritium than possible from nuclear power generation would be necessary to make a measurable change in the environmental tritium concentrations.

PHOTO: E. DELICATE

# MONITORING PROGRAM

# RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM

## Program Design

The Radiological Environmental Monitoring Program (REMP) at Davis-Besse was established to ensure that any radiological environmental effects would be detected and to comply with NRC regulations. The NRC requires Davis-Besse to monitor the plant environs for radioactivity which may be released as a result of normal operations and postulated accidents. The objectives of Davis-Besse's Radiological Environmental Monitoring Program are:

- To assess public exposure due to the operation of the plant
- To evaluate the effect, if any, of the plant on important exposure pathways
- To identify physical and biological sites of the build-up of radioactivity, if any, in the environment and resulting changes in background radiation levels
- To verify the adequacy of in-plant controls of radioactive materials

Because of the many potential pathways of radiation exposure from both natural and man-made sources, the levels of radioactivity in an area (and how it varies) must be documented.

## Exposure Pathways

The potential for receiving radiation exposure from an internal source of radiation exists if an individual breathes air, drinks water, or consumes food containing radioactivity. The potential pathways leading to human internal exposures from liquid and gaseous effluents are many and for certain nuclides may be complex. For example, airborne releases may deposit radionuclides in the environment where they may be deposited on or taken up by farm crops or vegetation used for animal feed. Human consumption of these products (meat and milk) may contribute to internal dose. For these reasons, large numbers of representative environmental samples are collected and analyzed for radioactivity. These samples include milk, fruits, vegetables, drinking water, Lake Erie water, well water, edible meat, fish, lake bottom sediments, soil, and air. During 1987, approximately 2000 environmental samples were collected and over 2,800 analyses performed.

Fig. 2-1: Local fruits, vegetables, milk, water, fish, soil, and air are sampled as part of the radiological monitoring program.

## Sampling

A radiological environmental monitoring program consists of two phases - the preoperational and the operational. The preoperational phase provides data which are used as a basis for evaluating increases in radiation levels and radioactivity in the vicinity of the plant after it becomes operational.

An extensive preoperational radiological environmental monitoring program was initiated at the Davis-Besse site in 1972. This program included collection and

**Table 2-1**
**Background Radioactivity**

| Type of Sample | Radioactivity |
|---|---|
| Airborne Particulate | 0.1 pCi/$m^3$ |
| Surface Water | 4 pCi gross beta/l |
| Drinking Water | 3 pCi gross beta/l |
| Ambient Radiation | 8-22 mr/qtr. |
| Fish | 2 pCi gross beta/gram-wet |

analyses of airborne particulates, airborne iodine, milk, ground water, meat and wildlife, fruits and vegetables, animal and wildlife feed, soil, surface water, fish, and bottom sediments and measurements of direct radiation. For approximately 5 years before the initial operation of Davis-Besse, monitoring was conducted to accumulate data on the background radiation and radioactivity at the Davis-Besse site. Some examples of background radioactivity are listed in Table 2-1.

The data collected prior to the operation of Davis-Besse provides an extensive background of information which can be used to evaluate any increases in the radiation and radioactivity levels in the environment which may occur while the plant is operating.

Fuel elements were loaded in the plant on April 23 through April 27, 1977 and operation began on August 12, 1977. Approximately ten and one-half years of operational monitoring was completed by the end of December, 1987.

The operational radiological monitoring program is similar to the preoperational program. Sampling includes the collection and analyses of airborne particulates, airborne iodine, treated and untreated surface water, ground (well) water, fish, green leafy vegetables, milk, soil samples, lake bottom sediments, meat and wildlife and the measurement of direct radiation.

The selection of sampling locations was based upon meteorological data, measuring the prevailing wind direction in the area, hydrological (water) data, and the locations of the main intakes of water from Lake Erie which are used by the nearby population. The selection of sampling locations was also based on the analysis of pathways in the environment. Since the site is located in an agricultural region, milk and food crops from the area were also sampled. Sampling includes indicator and control locations. Indicator locations are those which

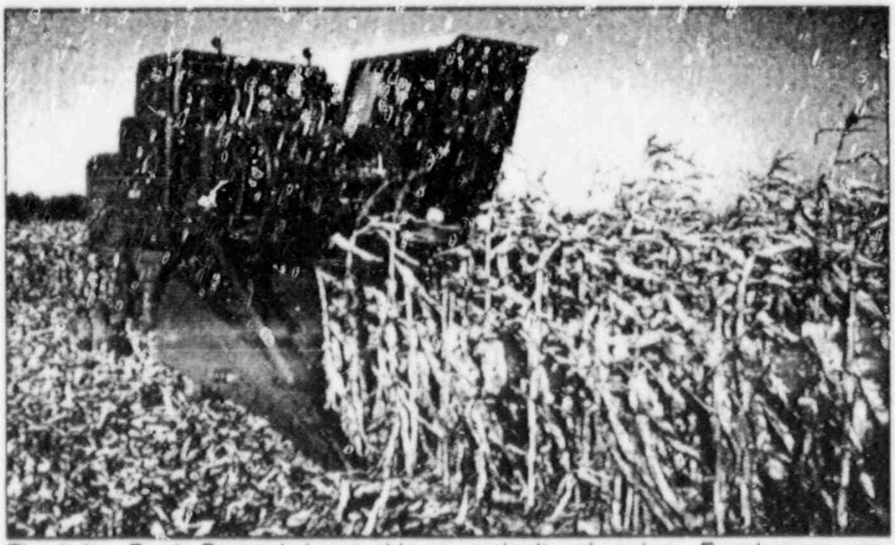


Fig. 2-2: Davis-Besse is located in an agricultural region. Food crops are included as part of the sampling program.

would be likely to show the effects of the plant operation. Generally, they are within 5 miles of the plant and are located where the highest exposures are predicted to occur. Control locations are selected so as not to be influenced by any plant operation. Typically, they are located at 5 miles or more from the plant. A comparison of the results of control and indicator samples allows for the evaluation of the samples while taking into account normally occurring background radioactivity and fluctuations due to events such as cosmic radiation and nuclear fallout from weapons testing. Figures 2-3, 2-4, and 2-5 show the sampling locations. Table 2-2 lists and describes all sample locations. Table 2-3 provides a list of sampling locations, type of location, type of sample, and collection frequency. Table 2-4 explains the codes used in Table 2-3 and in Figures 2-3, 2-4, and 2-5.

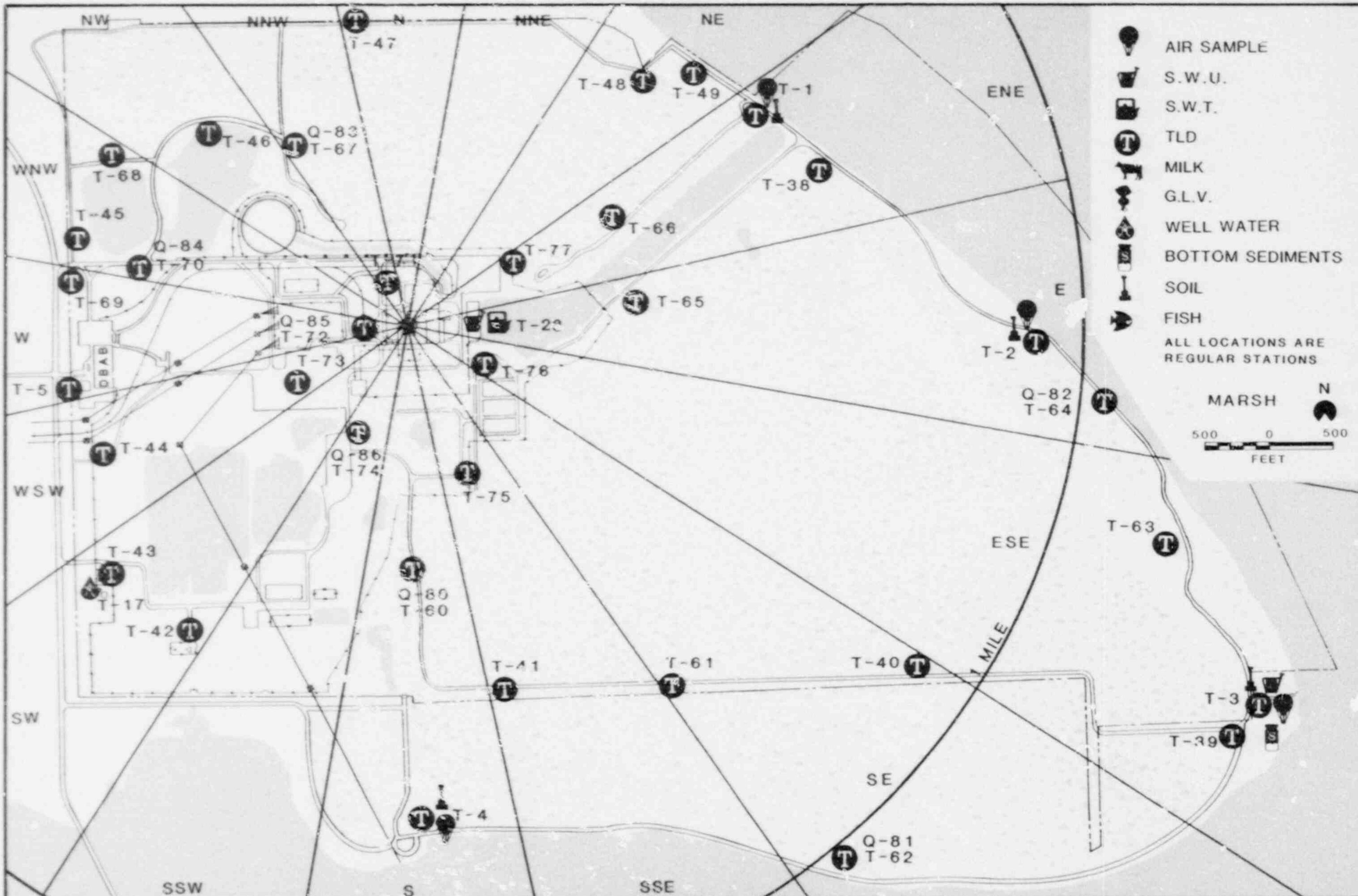
The sampling frequency for the various media was chosen based upon the radionuclides, their half-lives, and their behavior in the biological and physical environment. Iodine-131, for example, has a short half-life (8 days). Because of this short half-life, the sampling frequency of milk is increased from monthly to twice a month during the summer grazing months. However, since iodine-131 is also sampled in the air on a weekly schedule at 10 locations around the site, if there were a significant release of iodine from Davis-Besse or any nearby nuclear station or from an atmospheric weapons test, iodine-131 would be detected.

In 1987, the radiological environmental monitoring program was expanded and several special studies were conducted. This was done to increase the number of sampling locations and the types of samples being collected to assure that Davis-Besse is conducting a thorough and comprehensive study of the radioactivity present in the environment. In 1987, the TLD radiation monitoring program was expanded to include more locations. The number of locations was increased from 31 to 72. Also, a second type of TLD was placed in the field so the measurements of the two types of TLD's could be compared to ensure the radiation measurements were accurate. Duplicate TLD's, two TLD's of the same type at one location, were also used to ensure the accuracy of radiation measurements.

In 1987, a new milk sampling location was added to the program to provide more data on the background radioactivity in milk. Also, a fish sample, carp, was collected onsite and was compared to carp samples collected in Lake Erie. Lake water samples were collected from a boat offshore and along the coast. This provided information on the levels of radioactivity that are present in the lake in areas where people usually swim, boat and fish.

Fig. 2-3: **DAVIS-BESSE NUCLEAR POWER STATION RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM**

SAMPLING LOCATIONS - SITE AREA

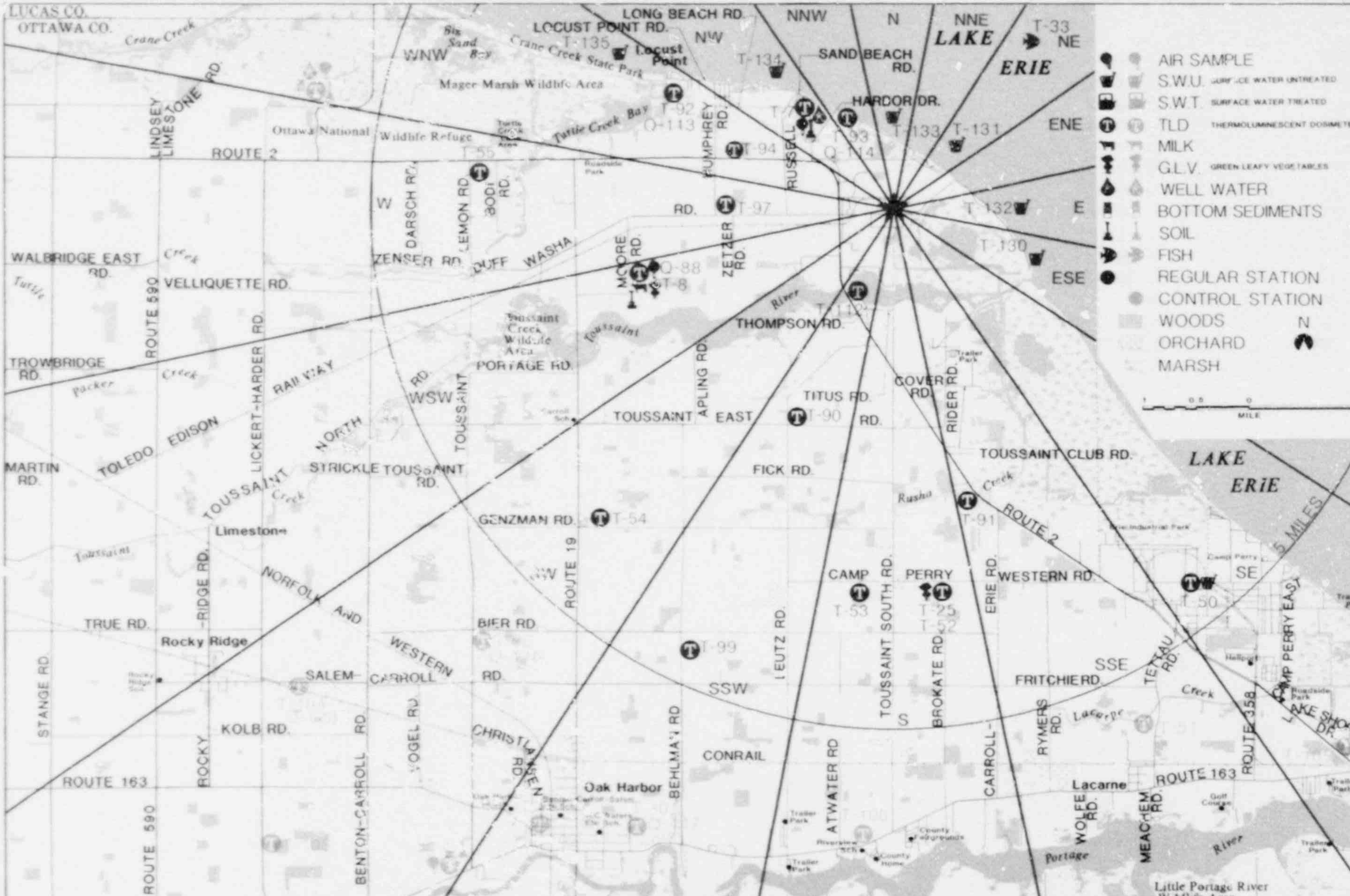



NUCLEAR HEALTH AND SAFTY DIVISION
ENVIRONMENTAL COMPLIANCE DEPARTMENT

TOLEDO EDISON

Fig. 2-4: **DAVIS-BESSE NUCLEAR POWER STATION RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM**

SAMPLING LOCATIONS — 5 MILES RADIUS

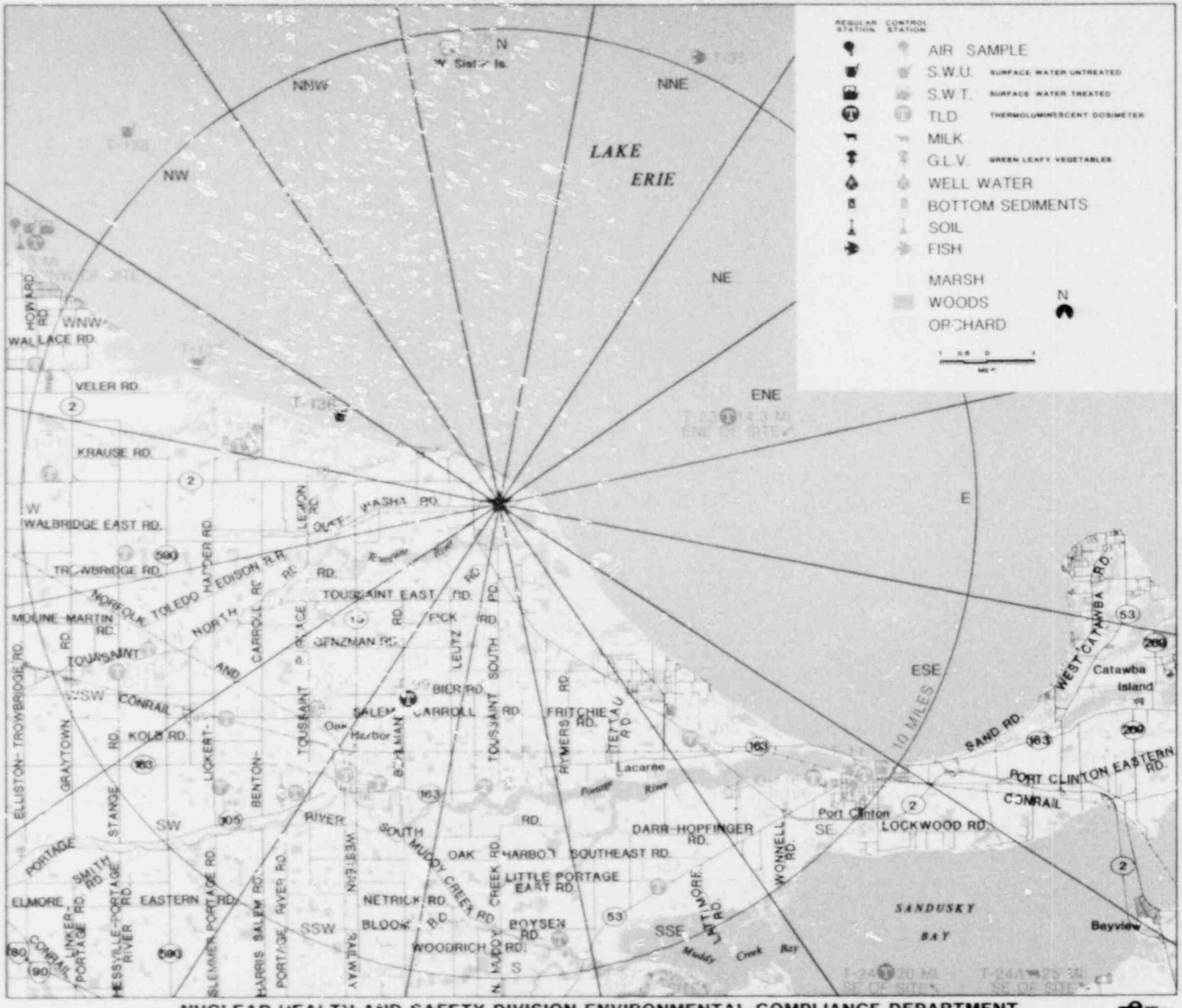



NUCLEAR HEALTH AND SAFETY DIVISION

ENVIRONMENTAL COMPLIANCE DEPARTMENT

TOLEDO EDISON

Fig. 2-5: **DAVIS BESSE NUCLEAR POWER STATION**
**RADIOLOGICAL ENVIRONMENTAL MONITORING PROGRAM**
SAMPLING LOCATIONS – 10 MILES RADIUS




NUCLEAR HEALTH AND SAFETY DIVISION ENVIRONMENTAL COMPLIANCE DEPARTMENT

# Table 2-2

## Sampling Locations

| Code | Type of Location* | Location Description |
|---|---|---|
| T-1 | I | Site boundary, 0.6 miles ENE of station, near intake canal. |
| T-2 | I | Site boundary, 0.9 miles E of station. |
| T-3 | I | Site boundary, 1.4 miles ESE of station, near Toussaint River and storm drain. |
| T-4 | I | Site boundary, 0.8 miles S of station, near Toussaint River. |
| T-5 | I | Main entrance to site, 0.5 miles W of station. |
| T-7 | I | Sand Beach, 0.9 miles NW of station. |
| T-8 | I | Earl Moore Farm, 2.7 miles WSW of station. |
| T-9 | C | Oak Harbor, 6.8 miles SW of station. |
| T-11 | C | Port Clinton, 9.5 miles SE of station. |
| T-12 | C | Toledo Water Treatment Station, airborne particulate and iodine collected 23.5 miles WNW of station and water samples taken from Intake Crib 11.25 miles NW of station. |
| T-17 | I | Irv Fick's well onsite, 0.7 miles SW of station. |
| T-20 | I | Gaeth Farm, 5.5 miles WSW of station. |
| T-23 | C | Put-In-Bay Lighthouse, 14.3 miles ENE of station. |
| T-24 | C | Sandusky, 24.9 miles SE of station. |
| T-25 | I | Miller Farm, 3.7 miles S of station. |
| T-27 | C | Magee Marsh, 5.3 miles WNW of station. |
| T-28 | I | Unit 1 treated and untreated water supply, onsite. |
| T-31 | I | Onsite. |
| T-33 | I | Lake Erie, within 5 miles radius of site. |
| T-34 | C | Land, greater than 10 miles radius of site. |
| T-35 | C | Lake Erie, greater than 10 miles radius of site. |

* I = Indicator C = Control

# Table 2-2
## Sampling Locations
**(continued)**

| Code | Type of Location* | Location Description |
|---|---|---|
| T-37 | C | The farm 10 to 20 miles from the site in the least prevalent wind direction. |
| T-38 | I | Site boundary, 0.6 miles ENE of station near lake. |
| T-39 | I | Site boundary, 1.2 miles ESE of station near ditch to Toussaint. |
| T-40 | I | Site boundary, 0.7 miles SE of station near ditch to Toussaint. |
| T-41 | I | Site boundary 0.6 miles SSE of station near ditch to Toussaint. |
| T-42 | I | Site boundary, 0.8 miles SW of station by meteorological tower. |
| T-43 | I | Site boundary, 0.5 miles SW of station along Route 2 fence. |
| T-44 | I | Site boundary, 0.5 miles WSW of station by railroad tracks. |
| T-45 | I | Site boundary, 0.5 miles WNW of station on access road behind cooling tower. |
| T-46 | I | Site boundary, 0.5 miles NW of station along access road. |
| T-47 | I | Site boundary, 0.5 miles N of station along access road by gate. |
| T-48 | I | Site boundary, 0.5 miles NE of station by lake. |
| T-49 | I | Site boundary, 0.5 miles NE of station along access road by lake. |
| T-50 | I | Erie Industrial Park, 4.5 miles SE of station by Water Tower. |
| T-51 | I | Daup Farm, 600 Tettau Road, Port Clinton, Ohio, 4.5 miles SSE of the station. |

* I = Indicator C = Control

## Table 2-2
## Sampling Locations
(continued)

| Code | Type of Location* | Location Description |
|---|---|---|
| T-52 | I | Miller Farm, 3.7 miles S of site on West Camp Perry Western Road. |
| T-53 | I | Nixon Farm, 4.5 miles S of site on West Camp Perry Western Road. |
| T-54 | I | M. Beier Farm, 4.8 miles SW of site on [illegible]enzman Road. |
| T-55 | I | King Farm, 5 miles west of site on Route 2. |
| T-57 | C | Meek's Farm, 22 miles SSE of station at 13[illegible]8 N. State Route 510, Fremont. |
| T-60 | I | Onsite, 0.3 mile S of station on south entrance road to marsh. |
| T-61 | I | Site boundary, 0.6 mile SE of Station near ditch to Toussaint. |
| T-62 | I | Site boundary, 1 mile SE of station, near Locust Point and Toussaint River. |
| T-63 | I | Site boundary, 1.1 miles ESE of station. |
| T-64 | I | Site boundary, 0.9 mile E of station. |
| T-65 | I | Onsite, 0.3 mile NE of station, near south site of intake canal. |
| T-66 | I | Onsite, 0.3 mile ENE of station, near north side of intake canal. |
| T-67 | I | Site boundary, 0.3 mile NNW of station, north of cooling tower. |
| T-68 | I | Site boundary, 0.5 mile WNW of station. |
| T-69 | I | Site boundary, 0.4 mile W of station, along side of Route 2. |
| T-70 | I | Onsite, 0.3 mile WNW of station by Visitor Processing Facility. |

* I = Indicator C = Control

# Table 2-2
# Sampling Locations
**(continued)**

| Code | Type of Location* | Location Description |
|---|---|---|
| T-71 | I | Onsite, 0.1 mile NW of station at Service Building #3. |
| T-73 | I | Onsite, 0.1 mile WSW of station in paved parking lot across from Personnel Processing Facility. |
| T-74 | I | Onsite, 0.1 mile SSW of station outside of trailer complex. |
| T-75 | I | Onsite, 0.2 mile SSE of station outside of Waste Water Treatment Plant. |
| T-76 | I | Onsite, 0.1 mile ESE of station on concrete building between settling pond and the station. |
| T-77 | I | Onsite, 0.1 mile ENE of station at Service Building #4. |
| T-78 | C | West Sister Island, 10 miles N of site. |
| T-79 | QC | Quality Control TLD, currently co-located with T-78. |
| T-80 | QC | Quality Control TLD, currently co-located with T-60. |
| T-81 | QC | Quality Control TLD, currently co-located with T-62. |
| T-82 | QC | Quality Control TLD, currently co-located with T-64. |
| T-83 | QC | Quality Control TLD, currently co-located with T-67. |
| T-84 | QC | Quality Control TLD, currently co-located with T-70. |
| T-86 | QC | Quality Control TLD, currently co-located with T-74. |
| T-87 | QC | Quality Control TLD, currently co-located at T Shield. |
| T-88 | QC | Quality Control TLD, currently co-located with T-8. |
| T-89 | QC | Quality Control TLD, currently co-located with T-27. |
| T-90 | I | Toussaint East and Leutz Roads, siren post no. 1106, 2 miles SSW of station. |
| T-91 | I | Rankie Road and State Route 2, siren post no. 1108, 2.5 miles SSE of station. |
| T-92 | I | Locust Point Road, 2.7 miles WNW of Station. |

* I = Indicator C = Control

# Table 2-2
# Sampling Locations

**(continued)**

| Code | Type of Location* | Location Description |
|---|---|---|
| T-93 | I | Sand Beach Road, 1.2 miles NNW of station. |
| T-94 | I | State Route 2 near Humphrey Road, 1.8 miles WNW of station. |
| T-95 | C | Route 579 W of State Route 2 junction on siren post no. 1202, 9.3 miles W of station. |
| T-96 | C | State Route 2 and Howard Road on siren post no. 3902, 10.5 miles WNW of station. |
| T-97 | I | Duff Washa and Zenser Road, 1.5 miles W of station. |
| T-98 | C | Portage and Bier Road on siren post no. 1109, 6 miles SW of station. |
| T-99 | I | Behlman Road south of Bier on siren post no. 1110, 4.7 miles SSW of station. |
| T-100 | C | Ottawa County Highway Garage, on State Route 163 on siren post no. 1404, 6 miles S of station |
| T-101 | C | Finke Street in Oak Harbor, on siren post no 1403, 6.5 miles SSW of station. |
| T-102 | C | Oak Street in Oak Harbor, on siren post no. 1402, 6.5 miles SSW of station. |
| T-103 | C | Lickert-Harder Road, S of State Route 163 and N of State Route 105, on siren post no. 1302, 8.5 miles SW of station. |
| T-104 | C | Salem-Carroll Road, 0.5 mile E of Rocky Ridge, on siren post no. 1213, 7.3 miles SW of station. |
| T-105 | C | Lake Shore Drive on siren post no. 1603, 6 miles SE of station. |

* I = Indicator C = Control

# Table 2-2
# Sampling Locations
(continued)

| Code | Type of Location* | Location Description |
|---|---|---|
| T-106 | C | Third Street in Port Clinton, on siren post no. 1503, 6.5 miles SE of station. |
| T-107 | C | Little Portage East Road, on siren post no. 1505, 8.5 miles SSE of station. |
| T-108 | C | Boysen Road on siren post no. 1504, 9 miles S of station. |
| T-109 | C | Stange Road, on siren post no. 1206, 8 miles W of station. |
| T-110 | C | Toussaint North and Graytown Road, on siren post no. 1 210, 10 miles WSW of station. |
| T-111 | C | Toussaint North Road, on siren post no. 1208, 8.3 miles WSW of station. |
| T-112 | I | Thompson Road, 1.5 miles SSW of station. |
| T-113 | QC | Quality Control TLD, for T-92. |
| T-114 | QC | Quality Control TLD, for T-93. |
| T-115 | QC | Quality Control TLD, for T-95. |
| T-116 | QC | Quality Control TLD, for T-98. |
| T-117 | QC | Quality Control TLD, for T-101. |
| T-118 | QC | Quality Control TLD, for T-106. |
| T-119 | QC | Quality Control TLD, for T-110. |
| T-120 | QC | Quality Control TLD, for T-104. |
| T-130 | I | Lake Erie, 1.7 miles ESE of station, 300 yards off-shore from mouth of Toussaint River. |
| T-131 | I | Lake Erie, 0.8 mile NE of station, about 300 yards off-shore of Intake Canal. |
| T-132 | I | Lake Erie, 1 mile E of station, about 600 yards off-shore by buoy J. |

* I = Indicator C = Control

# Table 2-2
# Sampling Locations
(continued)

| Code | Type of Location* | Location Description |
|---|---|---|
| T-133 | I | Lake Erie, 0.8 mile N of station, about 300 yards off-shore of Sand Beach. |
| T-134 | I | Lake Erie, 1.4 miles NW of station, 300 yards off-shore of Sand Beach. |
| T-135 | I | Lake Erie, 2.5 miles WNW of station, about 300 yards off-shore of Locust Point. |
| T-136 | I | Lake Erie, 3.8 miles WNW of station, about 300 yards off-shore. |
| T-137 | C | Lake Erie, 7 miles WNW of station, about 300 yards off-shore from Crane Creek State Park Beach. |
| T-138 | C | Lake Erie, 11 miles NW of Station, about 1000 yards from Toledo Water Treatment Station Intake Crib. |

* I = Indicator C = Control

# Table 2-3

## Type and Frequency of Collection

| Sampling Location | Type | Weekly | Monthly | Quarterly | Annually | Semi-Annually |
|---|---|---|---|---|---|---|
| 1 | I | AP AI | TLD | TLD | | SO |
| 2 | I | AP AI | TLD | TLD | | SO |
| 3 | I | AP AI SWU | TLD | TLD | BS | SO |
| 4 | I | AP AI | TLD | TLD | | SO |
| 5 | I | | TLD | TLD | | |
| 7 | I | AP AI | TLD | TLD WW | | SO |
| 8 | I | AP AI | TLD M*GLV** | TLD | | SO |
| 9 | C | AP AI | TLD | TLD | | SO |
| 11 | C | AP AI SWU | SWT TLD | TLD | | SO |
| 12 | C | AP AI SWU | SWT TLD | TLD | | SO |
| 17 | I | | | WW | | |
| 20 | I | | M* | | | |
| 23 | C | | TLD | TLD | | |
| 24 | C | | TLD M* | TLD | | |
| 25 | I | | GLV** | | | |
| 27 | C | AP AI | TLD | TLD WW | BS | SO |
| 28 | I | SWU | SWT | | | |
| 31 | I | | | | | WL |
| 33 | I | | | | | F |
| 35 | C | | | | | F |
| 37 | C | | GLV** | | | |
| 38-55 | I | | TLD | TLD | | |
| 50 | I | SWU | | | | |
| 57 | C | | M* | | | |
| 60-77 | I | | TLD | TLD | | |
| 78 | C | SWU | TLD | TLD | | |
| 79-89 | QC | | TLD | TLD | | |
| 90-94 | I | | TLD | TLD | | |
| 95-96 | C | | TLD | TLD | | |
| 97 | I | | TLD | TLD | | |
| 98 | C | | TLD | TLD | | |
| 99 | I | | TLD | TLD | | |
| 100-111 | C | | TLD | TLD | | |
| 112 | I | | TLD | TLD | | |
| 113-120 | QC | | TLD | TLD | | |
| 130-136 | I | SWU | | | | |
| 137-138 | C | SWU | | | | |

I = Indicator C = Control C = Quality Control

* Semi-monthly, May - October

**During growing season, July - September

Note: Sampling Codes used here are explained in Table 2-4

## Table 2-4
## Sample codes used in Table 2-3

| Code | Description |
|---|---|
| AP | Airborne Particulate |
| AI | Airborne Iodine |
| TLD(M) | Thermoluminescent Dosimeter - Monthly |
| TLD(Q) | Thermoluminescent Dosimeter - Quarterly |
| M | Milk |
| WW | Well Water (Ground Water) |
| GLV | Fruits and Vegetables |
| SWT | Surface Water - Treated |
| SWU | Surface Water - Untreated |
| F | Fish |
| BS | Bottom Sediments |
| SO | Soil |
| WL | Wildlife (meat sample) |

# Quality Assurance Program

Quality Assurance (QA) consists of all the planned and systematic actions that are necessary to provide adequate confidence in the results of an activity, in this case, our environmental monitoring program. In other words, QA is a program which provides a way to check the adequacy and validity of our monitoring program through written policies, procedures, and records.

The QA program at Davis-Besse is conducted in accordance with the guidelines specified in NRC Regulatory Guide 4.15, "Quality Assurance for Radiological Monitoring Programs". The program is designed to identify possible deficiencies so corrective actions may be immediately taken.

Davis-Besse's Quality Assurance program also provides confidence in the results of the monitoring program through:

- Regular audits (investigations) of the monitoring program
- Performing audits of analytical contractor laboratories
- Requiring analytical contractor laboratories to participate in the United States Environmental Protection Agency (US EPA) Cross-Check Program
- Requiring analytical contractor laboratories to split samples for separate analysis

- Splitting samples and having the samples analyzed by independent laboratories, and then comparing the results for agreement
- Requiring analytical contractor laboratories to perform in-house spiked sample analysis

QA audits and inspections of the Davis-Besse environmental monitoring program are performed by the US NRC, US EPA, Ohio EPA and independent groups, as well as Davis-Besse's QA department. In addition, the NRC and the Ohio Department of Health also perform independent monitoring of the Davis-Besse environment. The results of these programs are compared to the results obtained by Davis-Besse (see Appendix A).

The analytical laboratory used by Davis-Besse has its own internal quality control program for their TLD program. They have also participated in 5 International Interlaboratory Comparisons of Environmental Dosimeters (see Appendix B).

# 1987 Sampling Program

The sampling program was conducted in accordance with the Davis-Besse Nuclear Power Station Operating License, Appendix A Technical Specifications. The program included collection (both onsite and offsite) and analyses of airborne particulates, airborne iodine, ground (well) water, milk, edible meat, fruit, vegetables, soil, treated and untreated surface water, fish, lake bottom sediments, and measurements of direct radiation. All samples were sent to Teledyne Isotopes Midwest Laboratories, for analysis.

Results of sample analyses during the period of January - December 1987 are summarized in Table 2-5.

Radionuclide concentrations measured at indicator locations were compared with those measured at control locations and in preoperational studies. Sample results were also compared to the lower limit of detection (LLD) of the analysis being performed. The "lower limit of detection" is the smallest amount of sample activity that will give a net count for which there is a confidence at a predetermined level that the activity is present. We can compare the lower limit of detection (LLD) to the gasoline gauge in your car. When the marker reads empty, the tank still contains some small amount of gas that the meter cannot accurately measure. So when we say a measurement of radioactivity is below the LLD, it means that the activity is so low that the meter cannot accurately measure it with any degree of confidence (see Appendix C). The comparisons indicate background radioactivity in all samples collected in 1987. No effect on the environment due to the operation of Davis-Besse was indicated in any of the samples collected and analyzed. Table 2-6 presents a summary of sampling results from 1972 to 1987. A data summary of all samples collected in 1987 is presented in Appendix F.

The performance of the program is discussed in Table 2-5. The program was performed as described in the following sections with the following exceptions:

- There were no gross beta in air particulates, nor airborne iodine-131, data from location T-23 for the week of January 26, 1987 because samples were lost in transit to the laboratory.
- There were no gross beta in air particulates, nor airborne iodine-131 data from location T-4 for the weeks of March 9, 16, and 23, 1987 because of a power loss to the pump.
- Untreated surface water from Lake Erie at site boundary location T-3 was not collected during the month of February 1987 because the lake was frozen.
- There were no TLD data for location T-38 for the month of April and for the second quarter of 1987 because TLDs were lost due to vandalism.
- There were no TLD data for location T-54 for the month of June and for the second quarter of 1987, because TLDs were lost in the field.
- There were no TLD data for location T-45 for the month of October 1987, because TLDs were lost in transit to the laboratory.

Due to the number of sampling stations and the weekly sampling schedule of many of these locations, this loss of data is not significant.

The discussion of the results has been divided into four broad categories: the atmospheric, direct radiation, terrestrial, and aquatic environments. Within each category, the various samples collected are discussed.

# Table 2-5
# Sampling Summary, 1987

| Sample Type (Remarks) | Collection Type/ Frequency* | Number Of Locations | Number of Samples Collected | Number Samples Missed |
|---|---|---|---|---|
| **ATMOSPHERIC** | | | | |
| **Airborne Particulates** (See text p. 2-21) | C/W | 10 | 517 | 3 |
| **Airborne Iodine** (See text p. 2-21) | C/W | 10 | 517 | 3 |
| **DIRECT RADIATION** | | | | |
| **TLDs** (See text p. 2-21) | C/M | 72 | 371 | 1 |
| (31 original locations expanded to 72 by Dec. 87.) | C/Q | 72 | 122 | 2 |
| **TERRESTRIAL** | | | | |
| **Milk** (May - Oct.) (1 new location added Oct. 87.) | G/SM | 4 | 38 | 0 |
| (Nov. - Apr.) | G/M | 4 | 20 | 0 |
| **Well Water** | G/Q | 3 | 12 | 0 |
| **Edible Meat** (goose) | G/A | 1 | 1 | 0 |
| Fruits/Vegetables (Collected during growing season Jul. - Sep.) | G/M | 3 | 16 | 0 |
| **Soil** (Duplicate sample taken at T-12.) | G/A | 10 | 11 | 0 |

# Table 2-5
# Sampling Summary, 1987

**(continued)**

| **Sample Type**<br>(Remarks) | **Collection Type/ Frequency*** | **Number Of Locations** | **Number of Samples Collected** | **Number Samples Missed** |
|---|---|---|---|---|
| **AQUATIC** | | | | |
| **Treated Surface Water** | G/WM | 3 | 156 | 0 |
| **Untreated Surface Water**<br>(See text p. 2-21) | G/WM | 2 | 104 | 4 |
| | Comp/WM | 2 | 104 | 0 |
| | Comp/M | 1 | 12 | 0 |
| **Fish**<br>(2 species at each location; 3 species each in Oct.) | G/SA | 2 | 10 | 0 |
| **Bottom Sediments** | G/SA | 2 | 4 | 0 |

* Type of Collection:
C/ = Continuous
G/ = Grab
Comp/ = Composite

Frequency:
/WM = Weekly Composited Monthly
/W = Weekly
/SM = Semi monthly
/M = Monthly
/Q = Quarterly
/SA = Semi annually
/A = Annually

# Table 2-6
# Summary of Radiological Environmental Monitoring Program Results From 1972 Through 1987

| Monitoring | Results |
|---|---|
| **ATMOSPHERIC** | |
| Particulate | No radioactive particulates have been detected as a result of Davis-Besse operations. Only natural and fallout radioactivity from weapons testing and the nuclear accident at Chernobyl were detected. |
| Iodine | Radioactive iodine-131 fallout was detected in 1976, 1977, and 1978 from weapons testing and in 1986 (0.12 to 1.2 picocurie per cubic meter) from the nuclear accident at Chernobyl. |
| **DIRECT RADIATION** | |
| TLDs | The annual average dose rates have ranged between 49 and 87 millirem a year at control locations and between 44 and 63 millirem a year at indicator locations. No increase above natural background radiation was observed from routine plant operations. |
| **TERRESTRIAL** | |
| Ground Water | Only natural background radioactivity has been detected in well water. |
| Milk | Iodine-131 was detected in 1976 and 1977 from weapons testing fallout at concentrations of 1.36 and 23.9 picocuries/liter. In 1986, levels of |

# Table 2-6
# Summary of Radiological Environmental Monitoring Program Results From1972 Throurgh 1987

(continued)

| Monitoring | Results |
|---|---|
| **TERRESTRIAL** (Continued) | 8.5 picocuries/liter were detected from the nuclear accident at Chernobyl. No iodine-131 detected has been attributable to the operation of Davis-Besse. |
| Meat | Only naturally occurring potassium-40 and very low levels of cesium-137 have been detected in samples. Potassium-40 has ranged from 1.1 to 4.6 picocuries/gram wet weight. Cesium-137 was detected at a control location in 1974, 1975, and 1981. No radioactivity from Davis-Besse has been found in the local meat. |
| Fruits/Vegetables | Only natural and fallout radioactivity from weapons testing has been detected. |
| Soil | Only natural and fallout radioactivity from weapons testing and the nuclear accident at Chernobyl were detected. |
| **AQUATIC** | |
| Surface/Drinking Water | In 1979 and 1980, the tritium concentration at location T-7 was above normal background. Location T-7 is a beach well which is fed directly by Lake Erie. The fourth quarter sample in 1979 read 590 picocuries per liter and the first quarter sample in 1980 read 510 picocuries per liter |

# Table 2-6
# Summary of Radiological Environmental Monitoring Program Results From1972 Throurgh 1987

(continued)

| Monitoring | Results |
|---|---|
| **AQUATIC** (CONTINUED) | above the background concentration of 450 picocuries per liter A follow-up sample was collected in Lake Erie between T-7 and the station discharge and read 2737 picocuries per liter. These elevated concentrations could be attributed to the operation of Davis-Besse. However, the results at T-7 were more than thirty-nine times lower than the annual average concentration allowed by the EPA National Interim Primary Drinking Water Regulations (40 CFR 141) and were only 0.018% of the maximum permissible concentration for tritium in unrestricted areas (3,000,000 picocuries per liter). The follow-up sample was less than 0.1% of this concentration. All subsequent samples did not indicate any significant difference between the background tritium concentrations and the concentration at T-7. |
| Fish | Only natural and fallout radioactivity were detected in fish samples taken in 1972 - 1987. |
| Sediments | Only natural and fallout radioactivity from nuclear weapons testing and the nuclear accident at Chernobyl were detected. |

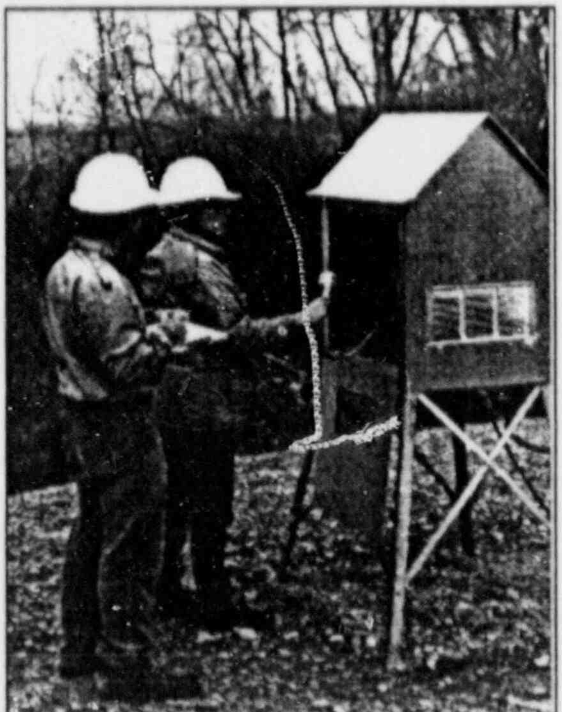


Fig. 2-6: Davis-Besse environmentalists perform weekly air sample monitoring.

## Atmospheric Monitoring

The atmosphere is one of the primary exposure pathways to people through breathing or ingesting radionuclides released to the atmosphere. Davis-Besse measures airborne radioactivity continuously at ten locations around the Station. The sampling locations are shown in Figures 2-3, 2-4, and 2-5. Table 2-2 describes the locations, listing for each, their direction and distance from the station and which are indicator and which are control locations. There are four indicator stations at the site boundary and two on private property, Sand Beach and a local farm. There are four control locations in nearby communities - Oak Harbor, Port Clinton, Toledo, and Magee Marsh. The control locations provide a measure of the background radioactivity for comparison with the indicator station results. Air samples are collected weekly and analyzed for radioiodine, strontium-89 and strontium-90, gross beta and gamma-emitting radionuclides.

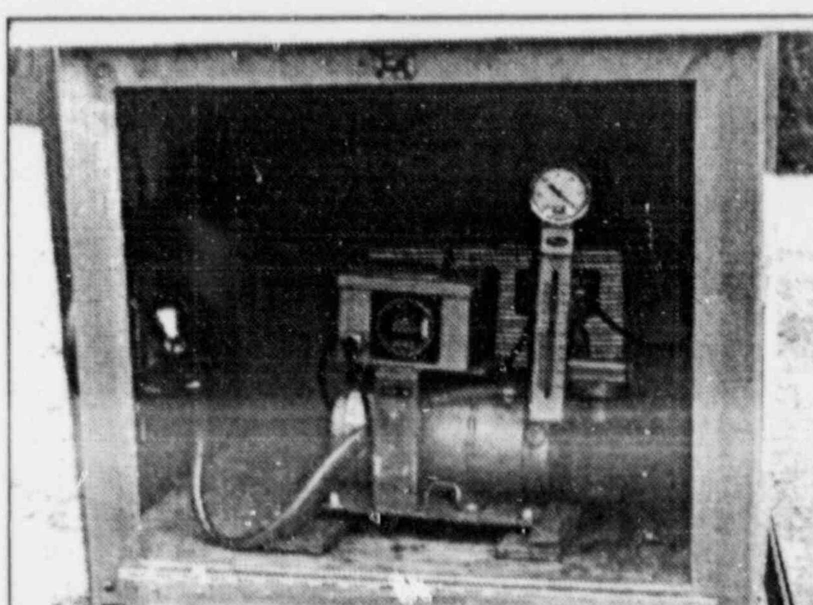


Fig. 2-7: These pumps are checked continuously and are carefully calibrated and maintained.

No contribution to the general level of airborne radioactivity could be identified as a result of the operation of Davis-Besse during 1987. The radioactivity detected is consistent with the levels normally found in the environment due to background radioactivity and fallout from nuclear weapons testing and the nuclear accident at Chernobyl.

## Collection and Analysis

Air sampling pumps are used to draw continuous samples. Air is drawn through particulate membrane filters and charcoal cartridges at a rate of about one cubic foot per minute. The total volume is calculated based on flow rate and running time. Air sampling pumps are checked and tested on a weekly basis and are calibrated at least every six months.

Air particulate filters are collected weekly at ten locations (T-1, T-2, T-3, T-4, T-7, T-8, T-9, T-11, T-12, and T-27). The filters are handled very carefully so as not to disturb any deposited particles. They are placed into individual glassine protective envelopes and sent to the laboratory for radiometric analyses.

Airborne particulate filters are analyzed weekly for gross beta radioactivity. Any filters showing high beta activity levels (greater than 10 times the yearly average of control samples) are analyzed by gamma spectroscopy to identify and measure gamma-emitting nuclides. Once a quarter, all filters from the indicator stations (T-1, T-2, T-3, T-4, T-7, and T-8) were composited (put together) and all the filters from the control stations (T-9, T-11, T-12, and T-27) were composited. These composite samples were analyzed for strontium-89 and strontium-90 and also analyzed by gamma spectroscopy using a Ge(Li) detector. This detector identifies and measures gamma emitting radioactivity.

Charcoal cartridges were installed downstream of the particulate filters to collect airborne radioiodine. These cartridges were collected and sent to the laboratory weekly. Iodine-131 was analyzed by gamma spectral analysis of the charcoal cartridges.

## Results

The airborne particulate and radioiodine analyses results for 1987 were within normal background levels, and no increases were noted as a result of the operation of Davis-Besse. The results are discussed below.

The maximum permissible concentrations of radioactivity in air above natural background radioactivity in unrestricted areas is limited by the Code of Federal Regulations, Title 10, Part 20, Table II. For beta emitting radioactivity the maximum allowable concentration is 100 $pCi/m^3$, and for iodine-131 it is 0.14 $pCi/m^3$

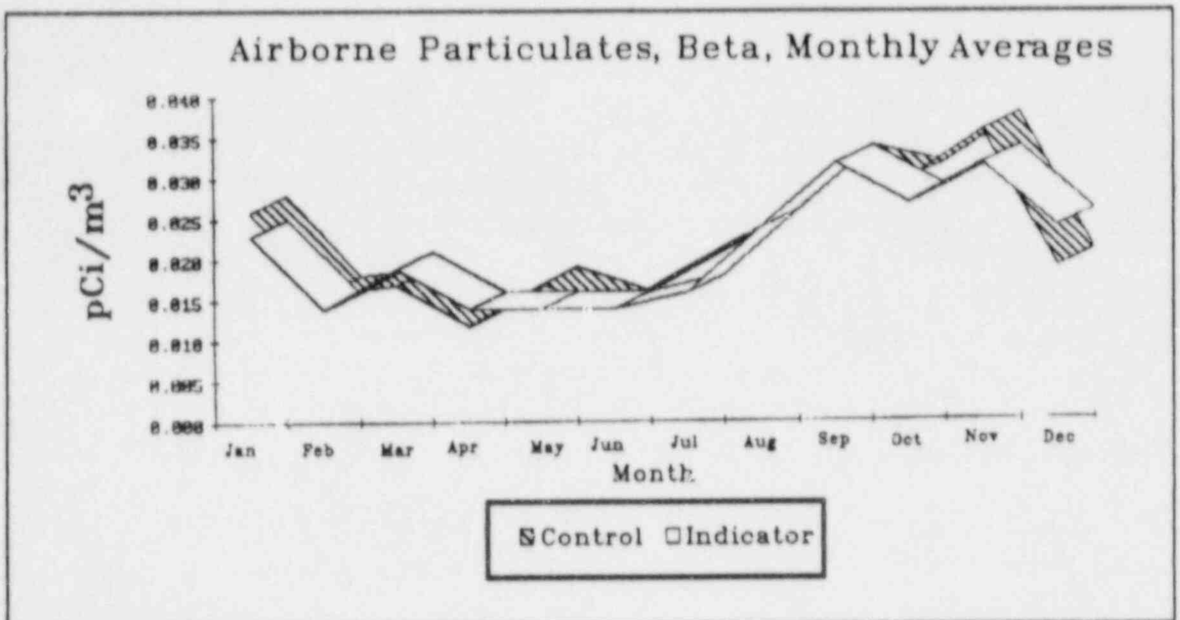



Fig. 2-8: This figure shows the excellent agreement between the control locations and the indicator locations.

## Table 2-7
## 1987 Average Beta Emitting Radioactivity

| Location | Annual | Average (pCi/m$^3$) |
|---|---|---|
| T-1 | (I) | 0.021 |
| T-2 | (I) | 0.023 |
| T-3 | (I) | 0.021 |
| T-4 | (I) | 0.022 |
| T-7 | (I) | 0.026 |
| T-8 | (I) | 0.018 |
| T-9 | (C) | 0.021 |
| T-11 | (C) | 0.023 |
| T-12 | (C) | 0.023 |
| T-27 | (C) | 0.0[illegible] |

(I) = Indicator Location (C) = Control Location

(adjusted upwards by a factor of 700 to determine the dose from the air-grass-cow milk-child pathway.)

Results of the gross beta airborne particulate analyses yielded annual means which were nearly identical at the four control locations and the six indicator locations, 0.022 $pCi/m^3$ and 0.023 $pCi/m^3$, respectively. Evidence for this may be seen in the similarity of the trends in the average monthly beta emitting radioactivity concentrations shown in Figure 2-8. The highest annual mean (0.024 $pCi/m^3$) was measured at the indicator location T-7. This is over 4,500 times less than the maximum permissible concentration. The activity was similar to 1986. The annual average of beta emitting radioactivity for each location are presented in Table 2-7. As you can see, the annual averages for each location are so close that the differences are not significant.

Strontium-89 and strontium-90 concentrations were below their respective lower limits of detection (LLD) of 0.005 and 0.001 $pCi/m^3$ in all samples.

Gamma spectroscopic analysis of quarterly composites of air particulate filters yielded similar results for indicator and control locations. Beryllium-7, which is produced continuously in the upper atmosphere by cosmic radiation, was detected in almost all samples. All other gamma-emitting radionuclides were below their respective LLDs during the year, with the exception of potassium-40 at T-8 for the fourth quarter. Potassium-40 is a naturally occurring isotope and the levels detected were small (0.045 $pCi/m^3$) and are attributable to normal background radiation.

Weekly levels of airborne iodine-131 were below the lower limit of detection (LLD) of 0.07 $pCi/m^3$ in 511 of the 525 samples analyzed. The LLD of 0.07 $pCi/m^3$ could not be reached in 14 samples because of low volume resulting from a pump malfunction (elevated airborne iodine results are presented in Appendix D).

# Direct Radiation Monitoring

Populations may be exposed to external radiation from several sources, including airborne effluents and deposition of radionuclides on soil or vegetation. Naturally occurring sources, including radiation of cosmic origin and natural radioactive materials in the air and ground, as well as fallout from weapons testing and the nuclear accident at Chernobyl, resulted in a certain amount of radiation being recorded at all monitoring locations. The amount of background radiation is determined from the TLDs located at the control sites. Results of the radiation monitoring program at Davis-Besse showed that the dose rates present during 1987 were similar to background radiation of previous years.

## Collection and Analysis

Radiation at and around Davis-Besse is constantly monitored by a network of thermoluminescent dosimeters (TLDs). TLDs are small radiation recording devices that store radiation dose information for long periods of time. They are precise and sensitive to small changes in radiation doses in the environment. Two types of TLDs were used at Davis-Besse in 1987. One type contained three calcium fluoride:manganese ($CaF_2$:Mn) bulbs. The second type was a calcium sulfate:dysprosium ($CaSO_4$:Dy) TLD card with 4 main readout areas. Multiple bulbs and readout areas are used to ensure the precision of the measurements.

Thermoluminescence is a process in which ionizing radiation interacts with the sensitive material, the phosphor, in the TLD. Energy is stored in "traps" in the TLD material. The TLD traps are so stable that they do not decay appreciably over months or even years. This provides an excellent method to measure doses received over long periods of time. The amount of energy that was stored in the TLD as a result of interaction with radiation is removed and measured by a controlled heating process in a calibrated reading system. As the TLD is heated, the phosphor releases the stored energy as light. The amount of light released is directly proportional to the amount of radiation to which the TLD was exposed. The reading process rezeros the TLD and prepares it for reuse.

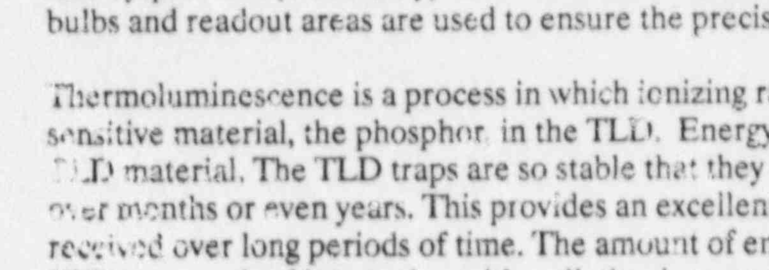


Fig. 2-9:TLD's constantly monitor radiation.

Fig. 2-10: These are the TLD's which are located at over 70 stations around Davis-Besse.

Two sets of TLD packets are placed at each location. One set is collected and replaced monthly. The second set is collected and replaced quarterly. The TLDs are sent to the laboratory to be read.

Davis-Besse had TLDs located at 31 locations at the beginning of 1987. There were 6 control stations (T-9, T-11, T-12, T-23, T-24, and T-27) located at 5 miles or more away from Davis-Besse, so as not to be influenced by the station. There were 25 indicator stations (T-1 through T-5, T-7, T-8, and T-38 through T-55).

In June, the TLD program was expanded to be more comprehensive and to include duplicate TLDs at many stations. Duplicate TLDs serve to provide quality control of results. By having two TLDs at the same location, readings obtained can be compared to provide assurance that analyses are being properly performed.

By the end of 1987 there were a total of 121 TLDs at 72 locations surrounding Davis-Besse (see Figures 2-3, 2-4, and 2-5). There were a total of 31 $CaF_2$:Mn bulbs and 90 $CaSO_4$:Dy cards. There were 22 control locations, 50 indicator locations and 18 quality control locations. Of the 121 TLDs, there were both $CaF_2$:Mn and $CaSO_4$:Dy TLDs at the 31 original locations and only $CaSO_4$:Dy TLDs at the 59 new locations (see Table 2-2).

The NRC also performs direct radiation monitoring at many locations at and around Davis-Besse. The NRC TLD Direct Radiation Monitoring Network for Davis-Besse Nuclear Power Station was established in the spring of 1980. The NRC has twenty-two (22) TLD stations distributed in two rings centered around the Davis-Besse radiological release stack. The inner ring is located within a two-mile radius and the outer ring is located within a five-mile radius of the site. Within each ring, a TLD station is located in each standard wind rose sector unless the sector consists entirely of open water or unoccupied, inaccessible land. The NRC dosimeter for each station is placed in a moisture-resistant polyester pouch inside a polypropylene mesh cylindrical container. The containers are attached to a relatively permanent structure, such as a utility pole. Once placed in the field, the NRC TLDs are not recovered until the next quarterly shipment is received.

### Results

Results of the radiation monitoring program at Davis-Besse indicated that the dose rates present during 1987 were similar to background levels of previous years (see Table 2-8).

The monthly and quarterly TLDs for the control and indicator locations showed almost identical readings with no significant variance. The results of these TLDs are shown on Table 2-8.

The annual average dose equivalent for all locations measured by monthly and quarterly TLDs was similar to previous years. They were:

- 1980 - 14.5 mrem/91 days
- 1981 - 14.8 mrem/91 days
- 1982 - 14.5 mrem/91 days
- 1983 - 13.2 mrem/91 days
- 1984 - 13.2 mrem/91 days
- 1985 - 14.4 mrem/91 days
- 1986 - 14.8 mrem/91 days
- 1987 - 14.5 mrem/91 days

**Table 2-8**
**Average TLD Dose**

| Location | Monthly (mrem/91 days*) | Quarterly (mrem/91 days) |
|---|---|---|
| Control | 15.1 | 14.3 |
| Indicator | 4.7 | 13.9 |

## Table 2-9
## COMPARISON OF $CaF_2$:Mn AND $CaSO_4$:Dy TLD RESULTS
## QUARTERLY AVERAGE (mrem/91 days)*

| LOCATION | $CaF_2$:Mn | $CaSO_4$:Dy |
|---|---|---|
| T-1 | 11.2 | 10.5 |
| T-2 | 11.5 | 11.2 |
| T-3 | 11.5 | 11.5 |
| T-4 | 13.4 | 14.2 |
| T-5 | 11.8 | 11.3 |
| T-7 | 14.8 | 14.2 |
| T-8 | 17.3 | 18.2 |
| T-9 | 11.0 | 11.6 |
| T-11 | 13.7 | 13.8 |
| T-12 | 17.3 | 18.0 |
| T-23 | 11.1 | 12.7 |
| T-4 | 13.4 | 14.2 |
| T-5 | 11.8 | 11.3 |
| T-7 | 14.8 | 14.2 |
| T-8 | 17.3 | 18.2 |
| T-9 | 11.0 | 11.6 |
| T-11 | 13.7 | 13.8 |
| T-12 | 17.3 | 18.0 |
| T-23 | 11.1 | 12.7 |
| T-24 | 16.8 | 16.7 |
| T-27 | 14.8 | 15.6 |
| T-38 | 13.3 | 11.2 |
| T-39 | 12.2 | 14.4 |
| T-40 | 12.4 | 14.9 |
| T-41 | 12.5 | 11.9 |
| T-42 | 9.8 | 9.6 |
| T-43 | 14.4 | 14.7 |
| T-44 | 14.8 | 15.1 |
| T-45 | 16.1 | 18.3 |
| T-46 | 13.1 | 13.7 |
| T-47 | 9.4 | 8.4 |
| T-48 | 16.1 | 16.6 |
| T-49 | 10.7 | 10.6 |
| T-50 | 19.4 | 18.8 |
| T-51 | 15.1 | 14.1 |
| T-52 | 16.0 | 17.2 |
| T-53 | 15.6 | 18.4 |
| T-54 | 16.8 | 18.5 |
| T-55 | 11.7 | 16.5 |

*The TLD measurements of the four quarters of the year were averaged.

These values are lower than the estimated average natural background radiation for Middle America, 19.5 mrem/91 days.

A comparison of the $CaF_2$:Mn and $CaSO_4$:Dy TLDs at the 31 original locations showed very similar results (see Table 2-9). Also, a comparison of the QC TLDs with their counterparts also showed almost identical readings (see Table 2-10). There comparisons show the accuracy and consistency of the TLD radiation monitoring devices. Figures 2-11 and 2-12, present a comparison of results from control and indicator stations. These graphs show that the monthly and quarterly averages for all locations are almost identical.

For each NRC location, the results were compared to those of previous years and to those of Davis-Besse. The results were very similar. In 1986, the NRC TLDs averaged 16.6 mrem/91 days and in 1987 they averaged 16.5 mrem/91 days.

**Table 2-10**
**COMPARISON OF REGULAR TLD AND QC TLD RESULTS**
**QUARTERLY AVERAGE (mrad/91 days)***

| LOCATION<br>REGULAR | QC | REGULAR TLD | QC |
|---|---|---|---|
| 8 | 88 | 16.5 | 16.6 |
| 27 | 89 | 15.2 | 17.1 |
| 60 | 80 | 13.8 | 13.3 |
| 62 | 81 | 12.4 | 12.5 |
| 64 | 82 | 8.4 | 9.3 |
| 67 | 83 | 18.7 | 19.4 |
| 70 | 84 | 10.7 | 11.1 |
| 74 | 86 | 12.9 | 13.7 |
| 78 | 79 | 14.6 | 18.8 |
| 92 | 113 | 12.4 | 14.4 |
| 93 | 114 | 11.9 | 14.1 |
| 95 | 115 | 15.3 | 15.7 |
| 98 | 116 | 13.2 | 15.9 |
| 101 | 117 | 13.5 | 15.6 |
| 106 | 118 | 15.5 | 14.8 |
| 110 | 119 | 15.0 | 14.8 |
| 104 | 120 | 13.8 | 15.3 |

*Average of quarterly TLD measurements.

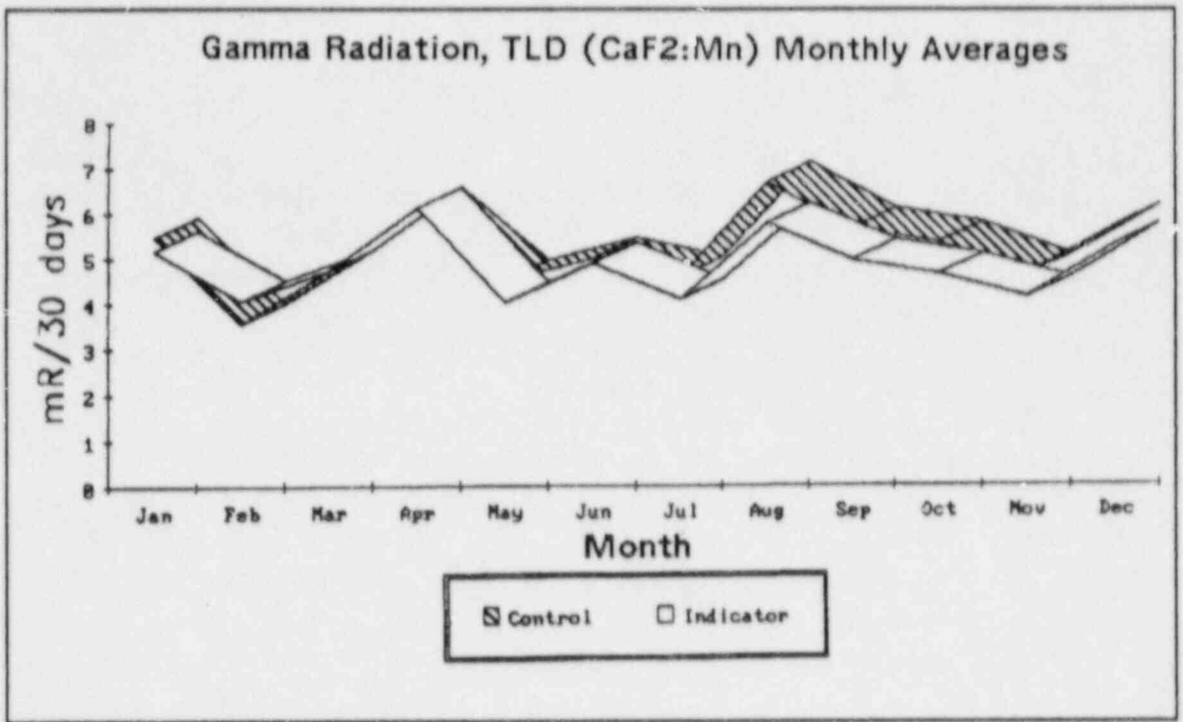



Fig. 2-11: The results of indicator and control locations are almost identical.

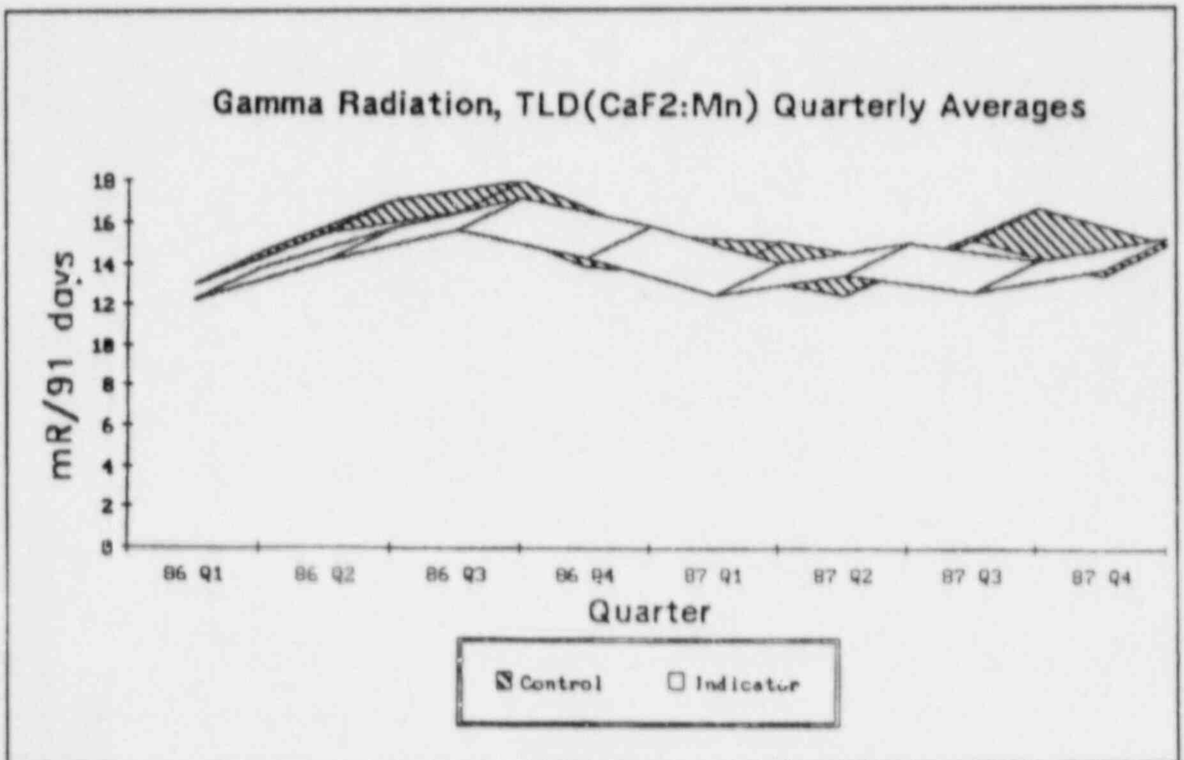



Fig. 2-12: The results of indicator TLD's closely match those at control locations.

# Terrestrial Monitoring

Sampling of food, milk, ground water and soil provide an estimate of radiation dose due to ingestion. Radionuclides can become incorporated into man's food chain by being deposited on plants and soil from atmospheric releases and also from irrigation of crops using lake water that receives liquid effluents (see Figures 1-11 and 1-12).

Radionuclides are present in the environment due to natural background radioactivity and from nuclear fallout. They are expected to be present to some extent in all samples collected. The contribution of radionuclides from the operation of Davis-Besse was assessed by comparing the results of samples collected at the indicator stations with the results of control samples and also with historical levels for background radiation and radioactivity.

A Land Use Census was conducted to determine the locations of the nearest milk animals and gardens, greater than 500 square feet producing broad leaf vegetation, in each of the 16 cardinal compass point sectors out to a distance of five miles. The results of this census are presented in the Land Use Census Section.

Davis-Besse monitors the terrestrial environment by collecting and analyzing samples of ground water, milk, edible meat, fruits, vegetables, and soil. The results of all samples collected in 1987 demonstrate that the operation of Davis-Besse did not significantly contribute to the radioactivity levels in the environment.

# Ground (Well) Water

Ground (well) water is not likely to be affected by the operation of Davis-Besse. It is not usually affected unless there are liquid discharges to the ground and Davis-Besse does not release by way of this pathway. However, to ensure that an up to date log of background data is maintained, samples are collected quarterly at three locations.

## Collection and Analysis

Grab samples of water were taken from three wells in the vicinity of the site every quarter (locations T-7, 17, and 27). The water was allowed to run for several minutes prior to sampling to ensure that a representative sample was obtained. All water samples were collected and stored in clean, unused containers.

Fig. 2-13: Samples of well water are collected quarterly.

One gallon was collected at each location and was shipped to the laboratory for analysis.

The samples were analyzed for beta emitting radioactivity in dissolved and suspended solids and for tritium. Then the samples for the two indicator locations (T-7 and 17) were combined and a gamma spectral analysis was performed to detect and identify gamma emitting radionuclides. Analysis for strontium (Sr-89 and Sr-90) was also performed on the combined indicator sample. The control sample (location T-27) was analyzed by gamma spectroscopy and for strontium-89 and strontium-90.

### Results

All well water samples collected in 1987 were below the lower limits of detection (LLD) for all analyses performed, except gross beta which was at normal concentrations. The operation of Davis-Besse had no detectable effect on radionuclide concentrations in ground (well) water.

Concentrations of beta emitting radioactivity in suspended solids were below the LLD of 0.5 pCi/l in all samples. Concentrations in dissolved solids averaged 3.3 pCi/l at the indicator locations and 4.8 pCi/l at the control location. The location with the highest annual average was the control location T-27 and was 4.8 pCi/l. Analysis of control samples indicate the normal background radioactivity. For the well water samples the control sample was higher than the indicator. Only background activity was detected and no detectable radioactivity from the operation of Davis-Besse was present. The range of beta radioactivity concentrations were similar to those observed in 1978 through 1986 (Table 2-6).

The tritium concentration was below the lower limit of detection in all samples.

Strontium-89 and strontium-90 concentrations were below their respective LLDs of 1.8 pCi/l and 1.0 pCi/l in all samples.

All samples were below the LLD of 10.0 pCi/l for cesium-137 concentration.

# Milk

Sampling of milk is important to the assessment of the dose consumed by man. Milk is one of the few food products that is consumed shortly after it is produced and is consumed by people of all ages, including infants.

The milk pathway consists of the deposition of radionuclides from atmospheric releases onto plants consumed by cows. The cows produce milk which is consumed by man (see Figure 1-12). The radionuclides of concern are primarily iodine-131 and strontium-89 and strontium-90 which tend to concentrate in milk.

## Collection and Analysis

Samples of untreated cow milk were collected monthly from November through April and semi-monthly from May through October (grazing season) from two locations (T-8 and T-20). Samples were also collected from a control location (T-24) in Sandusky, Ohio at the same frequency, as a measurement of background radioactivity. A second control location, T-57, was added in October. The samples were collected in clean, unused plastic containers. Two gallons were collected from each location and were shipped immediately, on ice, to the laboratory.

The samples were analyzed for iodine-131, strontium-89 and strontium-90, calcium, and stable potassium, and a gamma spectral analysis was performed.

Fig. 2-14: A total of 54 milk samples were collected and analyzed in 1987.

### Results

A total of 58 milk samples were collected and analyzed in 1987. The results obtained were similar to those of previous years.

A total of 58 analyses for iodine-131 in milk were performed during the reporting period. I-131 concentrations in these samples were below the LLD of 0.5 pCi/l.

Strontium-90 activity was detected in all samples collected and ranged from 0.5 to 2.8 pCi/l. The annual average value for strontium-90 was higher at control locations (1.4 pCi/l) than the indicator locations (1.34 pCi/l). Therefore there was no detectable effect from the operation of Davis-Besse. The location with the highest average (1.6 pCi/l) was control location T-24, which is still extremely low. The average values were similar to those measured from 1977 through 1986.

Strontium-89 was below the LLD of 1.0 pCi/l in all samples. The concentrations of barium-140 and cesium-137 were below 10 pCi/l in all samples collected

Results for potassium-40, a naturally occurring radionuclide, were similar at control and indicator locations (1347 and 1293 pCi/l, respectively). Indicator location T-20 had the highest average (1406 pCi/l). These results were very close to those observed in 1986, 1330 pCi/l at indicator and 1350 pCi/l at control locations.

Since the chemistries of calcium and strontium, and potassium and cesium are similar, organisms tend to deposit cesium-137 in muscle tissue and strontium-89 and strontium-90 in bones. In order to detect the potential environmental accumulation of these radionuclides, the ratios of strontium-90 activity to the weight of calcium and of the cesium-137 activity to the weight of stable potassium were monitored in milk. The measured concentrations of calcium and stable potassium were in agreement with previously determined standard values of 1.16 +/-0.08 g/l and 1.50 +/-0.21 g/l, respectively. No statistically significant variations in the ratios were observed.

## Edible Meat

Edible meat provides a source for the assessment of the indirect consumption pathway of radionuclides by people. Radionuclides may be deposited from the atmosphere on foods consumed by animals which are then consumed by humans.

### Collection [illegible]sis

One Ca[illegible]s collected onsite at T-31. The sample was shipped to the contracto[illegible], where a gamma spectral analysis was performed on the edible po[illegible]meat.

### Results

In the edible meat sample (Canada goose) the average potassium-40 concentration was 2.91 pCi/g wet weight, which is slightly lower than in 1986 (3.22 pCi/g wet). The cesium-137 concentration was below the LLD of 0.012 pCi/g wet weight. These values are similar to those obtained in previous years.

Fig. 2-15: Fruits and Vegetables are collected at 3 locations.

## Fruits and Vegetables

Fruits and vegetables may be directly or indirectly affected by radionuclide deposition. Radionuclides from atmospheric releases can be deposited on the outside of the fruits and vegetables. Also, radionuclides from the soil can be taken up by the plant's roots and become incorporated into the flesh of the fruit or vegetable.

Fruits and vegetables were collected at 2 indicator locations within 5 miles of the plant and at 1 control location greater than 10 miles from the plant.

### Collection and Analysis

Fruits and vegetables were collected monthly during the growing season (July, August and September). Samples were collected from 2 indicator locations

(T-8 and T-25) and 1 control location (T-37). A sample consists of 5 to 10 pounds of fruit or vegetable, depending on the water content. For example, more tomatoes are needed for analysis than carrots or beans.

The samples were collected and sealed in plastic bags to prevent loss of moisture, packed in a cooler on ice and shipped immediately to prevent spoilage. The edible portion was analyzed for strontium-89 and strontium-90 and by gamma spectroscopy.

### Results

Analyses of all fruit and vegetable samples indicated results that were either below lower detectable limits (LLD) or similar to results obtained in previous years. The results demonstrate that the operation of Davis-Besse caused no detectable radioactivity in fruits and vegetables.

Strontium-89 activity was below the LLD of 0.012 pCi/g wet weight in all samples. Strontium-90 was detected in two of seven samples at concentrations of 0.014 pCi/g wet weight, which is still very low and when compared to previous years. The average Sr-90 concentration in preoperational samples was 0.056 pCi/g wet weight and in operational samples was 0.023 pCi/g wet weight.

The only gamma-emitting radionuclide detected was naturally occurring potassium-40. The average concentrations were 3.63 pCi/g wet weight for the indicator locations and 1.64 pCi/g wet weight for the control locations. The concentrations detected were identical or similar to those detected in 1977 through 1986. All other gamma-emitting radionuclides were below their LLDs.

## Soil

Analysis of the soil provides a measurement of radionuclide deposition from the atmosphere. Soil analysis also aids in evaluating trends of long-term accumulation in the environment. Naturally occurring radionuclides (uranium, thorium) as well as fallout radionuclides (cobalt, strontium, and cesium) are expected to be present in these samples.

Soil samples were collected annually at 6 indicator locations within 3 miles of the site and at 4 control stations more than 5 miles away.

### Collection and Analysis

Soil samples were collected from all ten air sampling locations; six indicator locations (T-1, T-2, T-3, T-4, T-7 and T-8) and four control locations (T-9, T-11, T-12, and T-27). A duplicate quality control sample was collected at T-12. Each site was carefully checked to ensure it was undisturbed and with little vegetation. Approximately 5 pounds of soil were taken from the top two inches of soil at the site. The soil was sealed in a plastic bag and shipped to the contractor laboratory. Gamma spectral analyses were performed on all samples.

### Results

Soil samples were collected in June 1987 and analyzed for gamma emitting radionuclides. The predominant gamma emitting radioactivity was due to potassium-40 which had an average value of 9.45 pCi/g dry weight at the indicator locations and 15.4 pCi/g dry weight at the control locations. The samples collected from the control locations indicated a higher concentration of potassium-40 than the indicator stations. Only normally present background radioactivity was detected. Much of the potassium-40 in the soil is due to fertilizers. The cesium-137 concentration was above the LLD of 0.04 pCi/g in eight of the eleven samples. The average concentration at the indicator locations was 0.38 pCi/g dry weight and 0.58 pCi/g dry weight at the control locations. The highest cesium-137 concentration, 1.05 pCi/g dry weight, was detected at the indicator location T-8. The concentration and the distribution pattern were similar to those observed in 1978 through 1986. The lack of significant change over the years is evidence of the negligible impact of the operation of Davis-Besse on the environment in terms of radioactivity.

## Aquatic Monitoring

Lake Erie is a widely used source for drinking water, fishing and recreational activities. Hence, it is closely monitored for radionuclides. The main exposure pathway to man from waterborne radionuclides is through the consumption of drinking water, fish, aquatic wildlife, and irrigated crops. Hence, samples of treated (drinking) water and untreated water were collected. Sediments from the lake bottom were collected to provide an indication of the build-up of radionuclides which may affect people through aquatic species, resuspension into drinking water supplies and external radiation exposure to people in the water (swimmers, boaters). Treated and untreated surface water, fish, and lake bottom sediment samples were collected. The results of analyses of these samples demonstrate that the operation of Davis-Besse had no detectable effects on the aquatic environment.

Table 2-11
RADIOACTIVE ISOTOPE CONCENTRATIONS

| Isotope | Maximum Allowable Concentration |
|---|---|
| Barium-140 | 20,000 pCi/l |
| Cesium-137 | 20,000 pCi/l |
| Gross Beta | 100 pCi/l |
| Iodine-131 | 300 pCi/l |
| Potassium-40 (a natural radionuclide) | 3,000 pCi/l |
| Strontium-89 | 3,000 pCi/l |
| Strontium-90 | 300 pCi/l |
| Tritium | 3,000,000 pCi/l |

The maximum permissible concentrations of radioactivity in water above natural background in unrestricted areas are specified by the Code of Federal Regulations, Title 10, Part 20, Table II. The maximum allowable concentrations for radioactive nuclides found in water is given in Table 2-11.

## Treated Surface Water

Treated surface (drinking) water samples were collected and analyzed to determine the effect of the operation of Davis-Besse on the water being consumed.

### Collection and Analysis

Treated surface water used for drinking was collected at three locations on Lake Erie (T-11, T-12, and T-28). One location is onsite (T-28, Unit 1 treated water supply) and the other two are public water suppliers (Port Clinton and Toledo filtration plants). One quart of water was collected weekly from each location in a clean, unused plastic container.

The water samples were then sent to the analytical laboratory and were composited monthly. Analyses for beta emitting radionuclides in dissolved and suspended solids were performed. The samples from each location were combined quarterly and a tritium analysis was performed. Also, gamma spectral and strontium-89 and strontium-90 analyses were performed on quarterly composites of the indicator samples (T-28) and the two combined control samples (T-11 and T-12). Gamma spectral analyses would be performed on individual samples if the beta emitting radioactivity concentration in any single sample was greater than 10 pCi/l. No samples reached this criterion.

### Results

A total of 156 treated water samples were collected and analyzed in 1987. In treated water samples, the beta emitting radioactivity in suspended solids was below the LLD of 1.0 pCi/l in all samples, but one. The March sample at T-11, a control location, had beta radioactivity in suspended solids at concentrations of 2.1 pCi/l. The average concentration in dissolved solids was similar at indicator and control locations (1.6 and 2.1 pCi/l, respectively). The values are similar to those measured from 1975 through 1986. As you can see these concentrations are about 47 times lower than the maximum permissible concentration (100 pCi/l).

Tritium activity was below the lower limit of detection in all samples.

Strontium-89 and strontium-90 concentrations were below the LLD of 1.0 pCi/l in all samples except one sample at a control location. This sample had strontium-90 activity equal to the LLD of 1.0 pCi/l. The cesium-137 concentration was below the LLD of 10 pCi/l in all samples. Similar results were obtained from 1979 through 1986. Only normal background and fallout radioactivity were detected.

## Untreated Surface Water

The direction of movement of water in Lake Erie in the vicinity of the plant is not constant - there is no upstream or downstream direction. However, the overall flow is from west to east. Water samples were taken in the areas of the plant intake and discharge and at the designated water intake used by the surrounding populations for drinking and other purposes.

### Collection and Analysis

Untreated (raw) surface water was collected from two locations onsite and from three public water suppliers in order to detect any increases above background. Weekly, one quart samples of untreated water from Lake Erie were collected from one indicator location (T-3) and one control location (T-11). Samples were collected from a second control location (T-12) and a second indicator location (T-50) and composited monthly. Samples at locations T-11, T-12, and T-50 were collected from untreated water taps at Port Clinton, Toledo, and Erie Industrial Park filtration plants. In addition, a composite sample was collected from one in-plant water supply (T-28, Unit 1 untreated water supply, onsite) once a month. Samples were collected in new, clean plastic containers and shipped to the laboratory for analysis.

Fig. 2-16: Davis-Besse personnel collect lakewater weekly.

The samples from each location were composited monthly and analyzed for gross beta activity in dissolved and suspended solids. Quarterly composites from combined indicator and combined control locations were analyzed by gamma spectroscopy and analyzed for strontium-89 and strontium-90. Tritium analysis was performed on quarterly composites from each location.

Gamma spectral analyses would be performed on individual samples if the beta emitting radioactivity concentration in any single sample was greater than 10 pCi/l. However, samples did not reach this concentration.

## Results

In untreated water samples, the beta emitting radioactivity concentration in suspended solids averaged 1.2 pCi/l, which is just slightly above the LLD of 1.0 pCi/l, at indicator locations and were below the lower limit of detection at control locations. In dissolved solids the average concentration was nearly identical at both indicator and control locations (2.9 and 2.6 pCi/l respectively). For total residue, the average concentrations were 3.1 pCi/l at indicator locations and 2.6 pCi/l at control locations. None of these results indicate statistically significant differences between indicator and control locations. The sample results indicate only background radioactivity.

The tritium concentration was below the lower limit of detection in all samples.

Strontium-89 concentration was below the LLD of 1.0 pCi/l in all samples. Strontium-90 concentration was slightly above the LLD of 0.6 pCi/l. At indicator locations it was 1.0 pCi/l and at control locations it averaged 0.8 pCi/l.

Cesium-137 concentration was below the LLD of 10.0 pCi/l for all locations. These results indicate no detectable effect on area water from the operation of Davis-Besse.

## Lake Water

To provide a more comprehensive program, lake water samples were collected at 10 locations in Lake Erie from June to October. These samples help provide a more complete picture of the radioactivity in the water surrounding Davis-Besse, especially in areas where swimming, boating and fishing occur.

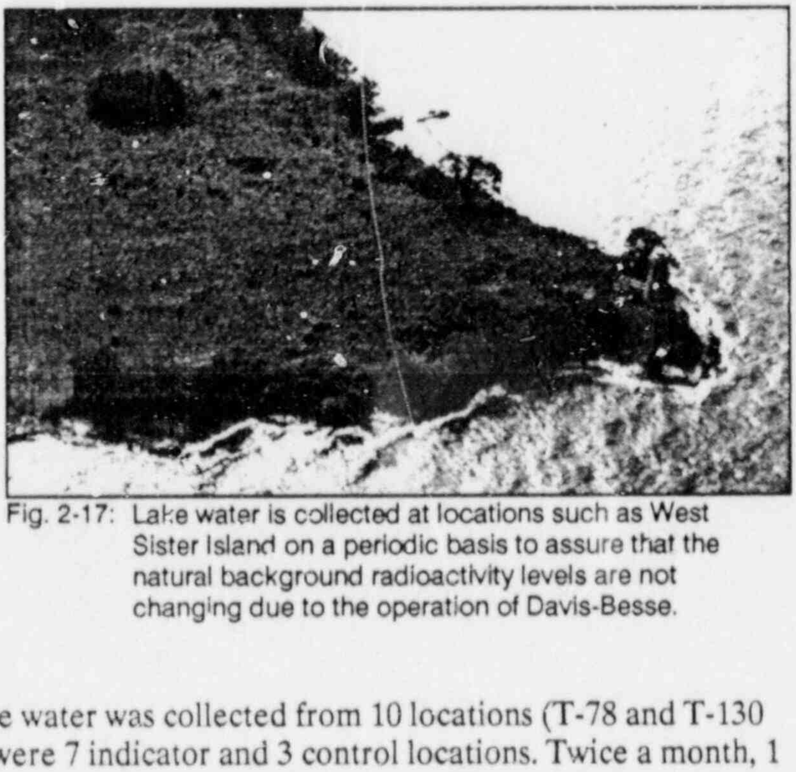


Fig. 2-17: Lake water is collected at locations such as West Sister Island on a periodic basis to assure that the natural background radioactivity levels are not changing due to the operation of Davis-Besse.

### Collection and Analysis

Untreated (lake) surface water was collected from 10 locations (T-78 and T-130 through T-138). There were 7 indicator and 3 control locations. Twice a month, 1 quart samples were collected and sent to the laboratory. These samples were composited monthly and analyzed for beta emitting radioactivity in dissolved and suspended solids, analyses for strontium-89 and strontium-90, as well as gamma emitting radionuclides were also performed.

### Results

In the lake water samples, the average beta emitting radioactivity concentration was 2.6 pCi/l at indicator locations and 2.7 pCi/l at control locations. The strontium-89 concentrations were below LLD in all samples. Strontium-90 concentrations were 0.8 pCi/l at indicator locations and 0.9 pCi/l at control locations. Cesium-137 was below the LLD of 10 pCi/l in all samples. As you can see, the results at the indicator and control locations were nearly identical. No radioactivity was detected due to the operation of Davis-Besse.

# Fish

The analysis of fish samples provide an indication of the type and activity of radionuclides consumed by humans.

## Collection and Analysis

Fish samples were collected semiannually in Lake Erie in the vicinity of Davis-Besse and from a control location greater than 10 miles from the site.

The sampling method for fish depends on the species of fish to be collected, location, and time of the year. Shore seines, nets, fish traps or hook and line are used to obtain fish samples. Commercial fishermen or sport fishermen were utilized to obtain samples. The samples were collected in such a manner to ensure the fish were fresh and the required information (such as species, date and location of collection) was provided.

Two species of fish (white bass and walleye) were collected semiannually from each of two locations in Lake Erie; one indicator location in the vicinity of the discharge (T-33) and one control location greater than 10 miles from the plant (T-35). In October, carp were also sampled at these 2 locations to provide a comparison for a carp sample collected onsite at T-4 in August. Five to ten pounds of each species were collected at each location and sealed in plastic bags and labeled. The fish were shipped immediately, on ice, to the laboratory. The flesh was separated from the bones and analyzed for beta emitting radioactivity and gamma emitting radionuclides.

## Results

The average beta emitting radioactivity concentration in fish muscle was similar for indicator and control locations (3.1 and 3.2 pCi/g wet weight, respectively). The control (background) locations had almost identical concentrations as the indicator locations. Only background activity is being detected.

The predominant gamma-emitting radionuclide detected was naturally-occurring potassium-40. The average potassium-40 concentration was 2.86 pCi/g wet weight for the indicator location and 2.85 pCi/g wet weight for the control loca-

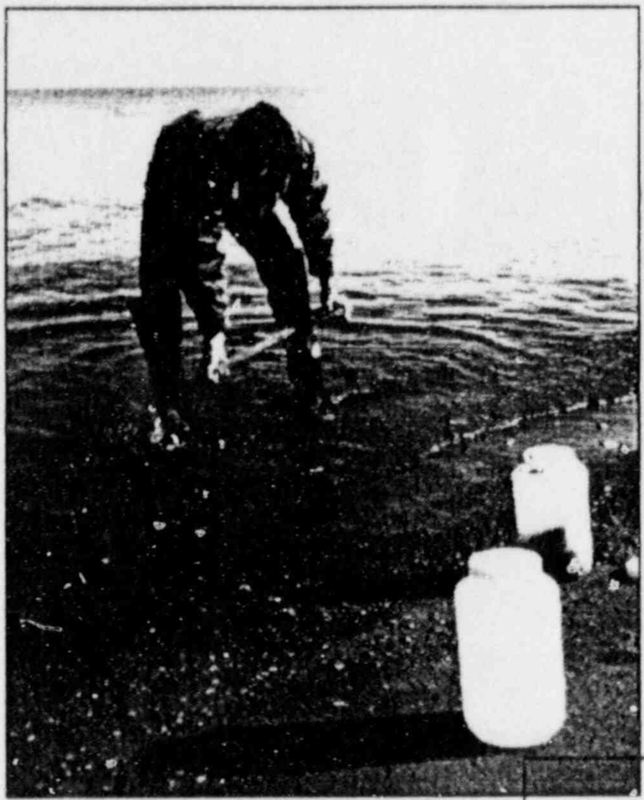


Fig. 2-18: Bottom sediments samples are collected offshore at two locations.

tion. The cesium-137 concentration was below the LLD level of 0.034 pCi/g wet weight in all samples. The concentrations were similar to those observed in 1978 through 1986.

## Bottom Sediments

Bottom sediment samples were taken to determine the build-up of radionuclides which might result from solids precipitating in the lake (build-up of radioactivity on the lake bottom).

### Collection and Analysis

Bottom sediment samples were collected semiannually at two locations along Lake Erie. They were collected using a shovel or similar device. Samples were taken from the lake bottom until at least 4 pounds had been collected at each location.

The samples were analyzed for gross beta activity, strontium-89 and strontium-90 and by gamma spectroscopy to identify and quantify gamma emitting radionuclides.

Fig. 2-19: Four pounds of sediment are collected at each site.

## Results

The average beta emitting radioactivity concentration in bottom sediments was 19.6 pCi/g dry weight for the indicator location and 13.4 pCi/g dry weight for the control location. The average potassium-40 concentration was 12.5 pCi/g dry weight for the indicator location and 8.8 pCi/g dry weight for the control location.

Strontium-89 was less than the lower limit of detection at indicator and control locations. Strontium-90 was 0.022 pCi/l at the indicator and 0.012 pCi/l at control locations. Cesium-137 was not detected in any of the samples. Similar activity, distribution and composition of detected radionuclides were detected from 1978 through 1986. Even though the indicator location activity was higher than the activity at the control location, there was not enough difference to be statistically significant. Analysis of bottom sediment samples collected in 1987 produced results comparable to those obtained in previous years. In previous years, including preoperational, the indicator locations showed higher activity than the control location. Hence, this is a normal distribution pattern.

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Note: Reports of past years were used for data comparison.

These reports include:

- Preoperational Evnironmental Monitoring Programs up through 1977.
- Annual Environmental Operating Reports for 1977 through 1986.

PHOTO: COURTESY OF USFWS

# LAND USE CENSUS

# LAND USE CENSUS

## Program Design

In order to monitor radioactive material in our surrounding environment, we must identify the various pathways by which radioactive material may reach the population. These pathways include:

- Inhalation Pathways - Internal exposure as a result of breathing radioactive material carried in the air.
- Ground Exposure Pathway - External exposure from radioactive material deposited on the ground.
- Plume Exposure Pathway - External exposure directly from a plume or "cloud" of radioactive material.
- Vegetation Pathway - Internal exposure as a result of eating plants, fruit, etc. which have a build-up of deposited radionuclides or have absorbed radioactive materials through the soil.
- Milk Pathway - Radionuclides are deposited on forage, eaten by a cow or goat, then passed into their milk which is consumed by humans causing internal exposure.

Identified pathways are investigated annually during the growing season for suitability of environmental sampling. This investigation is the Annual Land Use Census as required by Title 10 of the Code of Federal Regulations, Part 50, Appendix I, Section IV. B.3 and the Davis-Besse Technical Specifications, Section 3/4.12.2.

The Annual Land Use Census consists of recording and mapping the locations of all residences, milk cows or goats, and gardens (larger than 500 square feet) providing broad leaf vegetation. This investigation is performed within a five mile radius of the Davis-Besse site. This entails driving along all roads within a five mile radius of Davis-Besse to gather information.

Fig. 3-1: Davis-Besse personnel drive along every road within 5 miles of the plant to record all residences, vegetable gardens, milk cows, and goats.

The information gathered in this census is used in the dose assessment program and the radiological environmental monitoring program. This ensures the information used in these programs is up to date. For example, if the Land Use Census identified a new milk cow that was closer to the plant than the ones currently sampled, this location would be added to the environmental sampling program.

### Results

The 1987 Land Use Census was conducted on July 7, 1987 through July 23, 1987. In order to gather as much information as possible, the locations of residences, milk cows and goats, vegetable gardens, beef cows, fowl, fruit trees, grapes, sheep, and swine were recorded. The Ottawa County Cooperative Extension Agency confirmed the presence of milk cows and goats reported within the five mile radius.

The following changes were recorded in the 1987 census:

SSE Sector - The vegetable pathways at 2920, 8050, 8100, and 8180 meters were deleted. Vegetable pathways were added at 2830, 2900, 3800, 3840, 3920, 4830, 5760, 8680, 6720,7120, 7490, and 7690 meters. Three new residences were added at 4950, 7490, and 8230 meters.

S Sector - The vegetable pathway at 1430 meters was deleted. Vegetable pathways were added at 1930, 4040, 4980, 5640, 6470, 7170, 7440, and 7470 meters. Five new residences were added at 5460, 6530,7440, 7470, and 7430 meters.

SSW Sector - Vegetable pathways were added at 1310, 1550, 1820, 3650, 4280, 5010, 5830, 7410, 7600, 7630, and 7500 meters. Four new residences were added at 1820, 7410, 7600, 7630 meters.

SW Sector - The vegetable pathway at 5310 meters was deleted. Vegetable pathways were added at 1380, 3840, 4200, 4440, and 5080 meters. A new residence was added at 7290 meters.

WSW Sector - A new residence was added at 4910 meters.

W Sector - The vegetable pathway at 4950 meters was deleted. Vegetable pathways were added 3770 and 5380 meters. A new residence was added at 2790 meters.

WNW Sector - The vegetable pathway at 2280 meters was deleted and a vegetable pathway at 3800 meters was added.

NW Sector - Vegetable pathways were added at 2460 and 2790 meters. A new residence was added at 2790 meters. Sixteen new condominium residences were added at 1730, 1760, 1790, 1820, 1850, 1880, 1910, 1950, and 1980 meters.

NNW Sector - Vegetable pathways were added at 1330 and 1490 meters.

All locations were plotted on a map which had been divided into 16 equal sectors corresponding to the cardinal compass points (see Figure 3-2). Then the closest pathways (residence, milk animal, and vegetable garden) in each sector were determined. The distance of each pathway from Davis-Besse was then measured and the data was recorded on Table 3-1

The detailed pathway list in Table 3-2 is used to update the data base of the dispersion model used in dose calculations. Table 3-2 is divided by sectors and lists the distance (in meters) of the closest pathways located in each sector. A "1" indicates that a particular pathway is present at the distance indicated. In 1987 changes were recorded in the SSE, S, WNW, and NW sectors.

Table 3-3 is the updated table for Appendix B, Table 7 of the Offsite Dose Calculation Manual (ODCM). The ODCM describes the methodology and parameters used in calculating offsite doses from radioactive liquid and gaseous effluents, and in calculating liquid and gaseous effluent monitoring instrumentation alarm/trip setpoints.

The location of only two pathways changed in Table 3-3. The closest vegetation pathway in the SSE sector changed from a distance of 2920 meters to a distance of 2830 meters in 1987. The closest vegetation pathway in the WNW sector changed from a distance of 2280 meters to a distance of 2820 meters in 1987. The critical receptor of the 1987 Land Use Census has not changed since 1983. The vegetation pathway at 900 meters in the NNE sector is still the most critical receptor. Therefore, no change to the release rate calculation equations was necessary.

## Table 3-1
## Pathway Identification

| Sector | Distance (Meters) | Pathway |
|---|---|---|
| N | 870 | Residence |
| NNE | 870 | Residence |
| | 900 | Residence, Vegetable Garden |
| NE | 900 | Residence |
| ENE* | | |
| E* | | |
| ESE* | | |
| SE* | | |
| SSE | 2030 | Residence |
| | 2830** | Residence, Vegetable Garden |
| S | 1130 | Residence |
| | 1750** | Residence, Vegetable Garden |
| S | 1130 | Residence |
| | 1750** | Residence, Vegetable Garden |
| | 5860 | Residence, Vegetable Garden, Dairy Goat |
| SSW | 1000 | Residence, Vegetable Garden |
| SW | 990 | Residence |
| | 1360 | Residence, Vegetable Garden |
| WSW | 1640 | Residence, Vegetable Garden |
| | 4250 | Residence, Vegetable Garden, Dairy Cows |
| W | 980 | Residence, Vegetable Garden |
| WNW | 1520 | Residence |
| | 2820** | Residence, Vegetable Garden |
| NW | 1730** | Residence |
| | 2290 | Residence, Vegetable Garden |
| NNW | 1250 | Residence |
| | 1330 | Residence, Vegetable Garden |

* Sectors over Lake Erie and Marsh Areas
** Changes since 1986

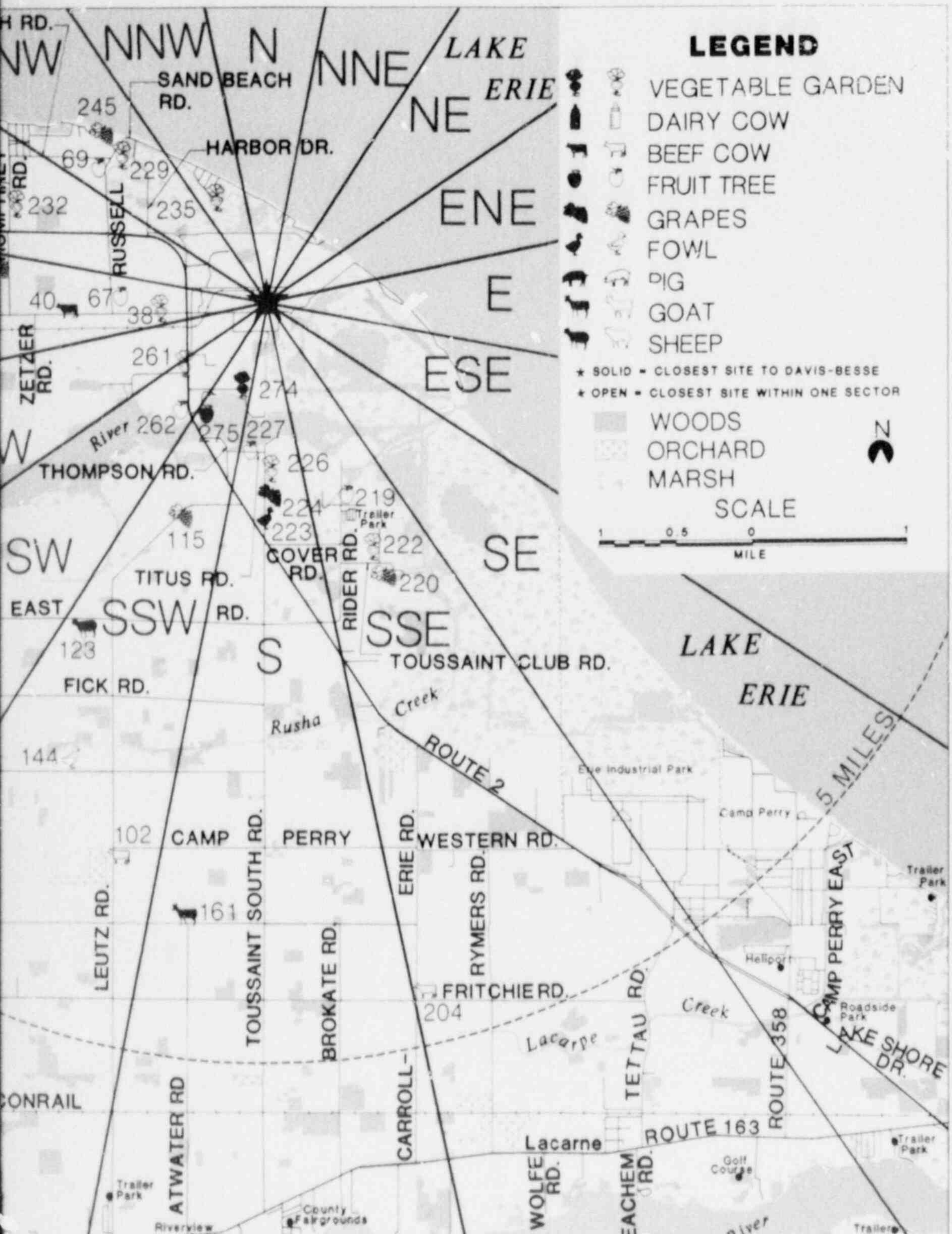
Fig. 3-2: **DAVIS-BESSE NUCLEAR POWER S**

CONSUMABLES WITH


NUCLEAR HEALTH AN
ENVIRONMENTAL COMP

## ...ATION LAND USE CENSUS 1987

### ...N 5 MILES RADIUS




...D SAFETY DIVISION

...LIANCE DEPARTMENT

TOLEDO EDISON

~~8804250201-02~~

## Table 3-2
## Receptor Distance from Site

| Sector/type | Distance/Pathway | |
|---|---|---|
| **SECTOR 1 (N)** | **870** | |
| Inhalation | 1 | |
| Contaminated Ground | 1 | |
| Vegetation | | |
| Cow Milk | | |
| Goat Milk | | |
| Plume Exposure | 1 | |
| **SECTOR 2 (NNE)** | **870** | **900** |
| Inhalation | 1 | 1 |
| Contaminated Ground | 1 | 1 |
| Vegetation | 1 | |
| Cow Milk | | |
| Goat Milk | | |
| Plume Exposure | 1 | 1 |
| **SECTOR 3 (NE)** | **900** | |
| Inhalation | 1 | |
| Contaminated Ground | 1 | |
| Vegetation | | |
| Cow Milk | | |
| Goat Milk | | |
| Plume Exposure | 1 | |
| **SECTORS 4, 5, 6, 7 over water** | | |
| (ENE, E, ESE, SE) | | |
| **SECTOR 8 (SSE)** | **2030** | **2830*** |
| Inhalation | 1 | 1 |
| Contaminated Ground | 1 | 1 |
| Vegetation | 1 | |
| Cow Milk | | |
| Goat Milk | | |
| Plume Exposure | 1 | 1 |

* Changes since 1986

# Table 3-2
## Receptor Distance from Site

(Continued)

| Sector/type | Distance/Pathway | | |
|---|---|---|---|
| **SECTOR 9 (S)** | **1130** | **1750*** | **5860** |
| Inhalation | 1 | 1 | 1 |
| Contaminated Ground | 1 | 1 | 1 |
| Vegetation | | 1 | 1 |
| Cow Milk | | | |
| Goat Milk | | | 1 |
| Plume Exposure | 1 | 1 | 1 |
| **SECTOR 10 (SSW)** | **1060** | | |
| Inhalation | | 1 | |
| Contaminated Ground | 1 | | |
| Vegetation | | | |
| Cow Milk | | | |
| Goat Milk | | | |
| Plume Exposure | 1 | | |
| **SECTOR 11 (SW)** | **990** | **1360** | |
| Inhalation | 1 | 1 | |
| Contaminated Ground | 1 | 1 | |
| Vegetation | | 1 | |
| Cow Milk | | | |
| Goat Milk | | | |
| Plume Exposure | 1 | 1 | |
| **SECTOR 12 (WSW)** | **1640** | **4250** | |
| Inhalation | | 1 | 1 |
| Contaminated Ground | 1 | 1 | |
| Vegetation | 1 | 1 | |
| Cow Milk | | 1 | |
| Goat Milk | | | |
| Plume Exposure | 1 | 1 | |

* Changes since 1986

# Table 3-2
## Receptor Distance from Site
(Continued)

| Sector/type | Distance/Pathway | |
|---|---|---|
| **SECTOR 13 (W)** | **980** | |
| Inhalation | 1 | |
| Contaminated Ground | 1 | |
| Vegetation | 1 | |
| Cow Milk | | |
| Goat Milk | | |
| Plume Exposure | 1 | |
| **SECTOR 14 (WNW)** | **1520** | **2820*** |
| Inhalation | 1 | 1 |
| Contaminated Ground | 1 | 1 |
| Vegetation | | 1 |
| Cow Milk | | |
| Goat Milk | | |
| Plume Exposure | 1 | 1 |
| **SECTOR 15 (NW)** | **1730*** | **2290** |
| Inhalation | 1 | 1 |
| Contaminated Ground | 1 | 1 |
| Vegetation | | 1 |
| Cow Milk | | |
| Goat Milk | | |
| Plume Exposure | 1 | 1 |
| **SECTOR 16 (NNW)** | **1250** | **1330** |
| Inhalation | 1 | 1 |
| Contaminated Ground | 1 | 1 |
| Vegetation | | 1 |
| Cow Milk | | |
| Goat Milk | | |
| Plume Exposure | 1 | 1 |

* Changes since 1986

## Table 3-3
## Controlling Pathways, Locations, and Atmospheric Dispersion Parameters

| Sector | Meters | Pathways | Age group | X/Q (sec/M3) | D/Q (M-2) |
|---|---|---|---|---|---|
| N | 870 | Inhalation | Child | 9.34E-7 | 8.55E-9 |
| NNE | 900 | Vegetation | Child | 1.19E-6 | 1.39E-8 |
| NE | 900 | Inhalation | Child | 1.26E-6 | 1.58E-8 |
| ENE* | N/A | N/A | N/A | N/A | N/A |
| E* | N/A | N/A | N/A | N/A | N/A |
| ESE* | N/A | N/A | N/A | N/A | N/A |
| SE* | N/A | N/A | N/A | N/A | N/A |
| SSE** | 2830 | Vegetation | Child | 6.99E-8 | 8.31E-10 |
| S | 5860 | Goat/Milk | Infant | 2.89E-8 | 1.66E-10 |
| SSW | 1000 | Vegetation | Child | 1.92E-7 | 4.18E-9 |
| SW | 1360 | Vegetation | Child | 2.05E-7 | 3.85E-9 |
| WSW | 4250 | Cow/Milk | Infant | 5.74E-8 | 5.36E-10 |
| W | 980 | Vegetation | Child | 6.21E-7 | 9.58E-9 |
| WNW** | 2820 | Vegetation | Child | 7.42E-8 | 6.86E-10 |
| NW | 2290 | Vegetation | Child | 7.02E-8 | 5.84E-10 |
| NNW | 1330 | Vegetation | Child | 2.15E-7 | 1.57E-9 |

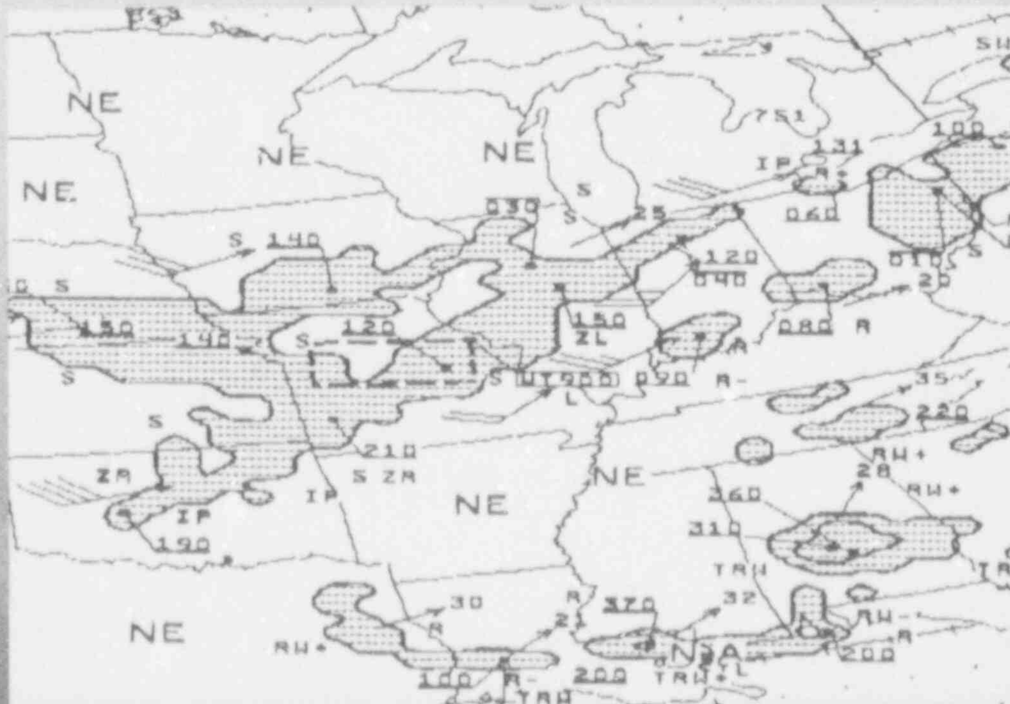
* Since these sectors are located over marsh areas and over Lake Erie, no ingestion pathways are present.

** Changes since 1986

ENVIRONMENTAL OPERATING REPORT

PHOTO: COURTESY OF USFWS

# ENVIRONMENTAL OPERATING REPORT




# METEOROLOGICAL MONITORING

# METEOROLOGICAL MONITORING

## Introduction

The Meteorological Monitoring Program at Davis-Besse is required by the Nuclear Regulatory Commission (NRC) as part of the program for evaluating the effects of routine operation of nuclear power plants on the surrounding environment. Both NRC regulations and Davis-Besse Technical Specifications provide guidelines for the Meteorological Monitoring Program. These guidelines ensure that Davis-Besse has the proper equipment, in good working order to support the Environmental Monitoring Program.

Meteorological observations at Davis-Besse began in October 1968. Measurements are made continuously and are monitored every day of the year. This provides an extensive record of meteorological information that can be used by many programs at Davis-Besse.

The Radiological Environmental Monitoring Program uses the meteorological data to evaluate the effects of routine effluent releases. The meteorological conditions at the time of these effluent releases are used to calculate doses to the general public. Meteorological data are also used to evaluate where new radiological monitoring sites should be located.

The Meteorological Monitoring system is especially valuable in monitoring weather conditions and predicting the development of adverse weather trends, such as flooding or high wind. This provides an early warning system, so precautions can be taken to protect the facilities and personnel at Davis-Besse, as well as the surrounding local residents.

Onsite meteorological data would also be a valuable tool in the unlikely event of an emergency at Davis-Besse. Atmospheric dispersion characteristics necessary for evaluating conditions, distribution, and doses to the public could be readily obtained.

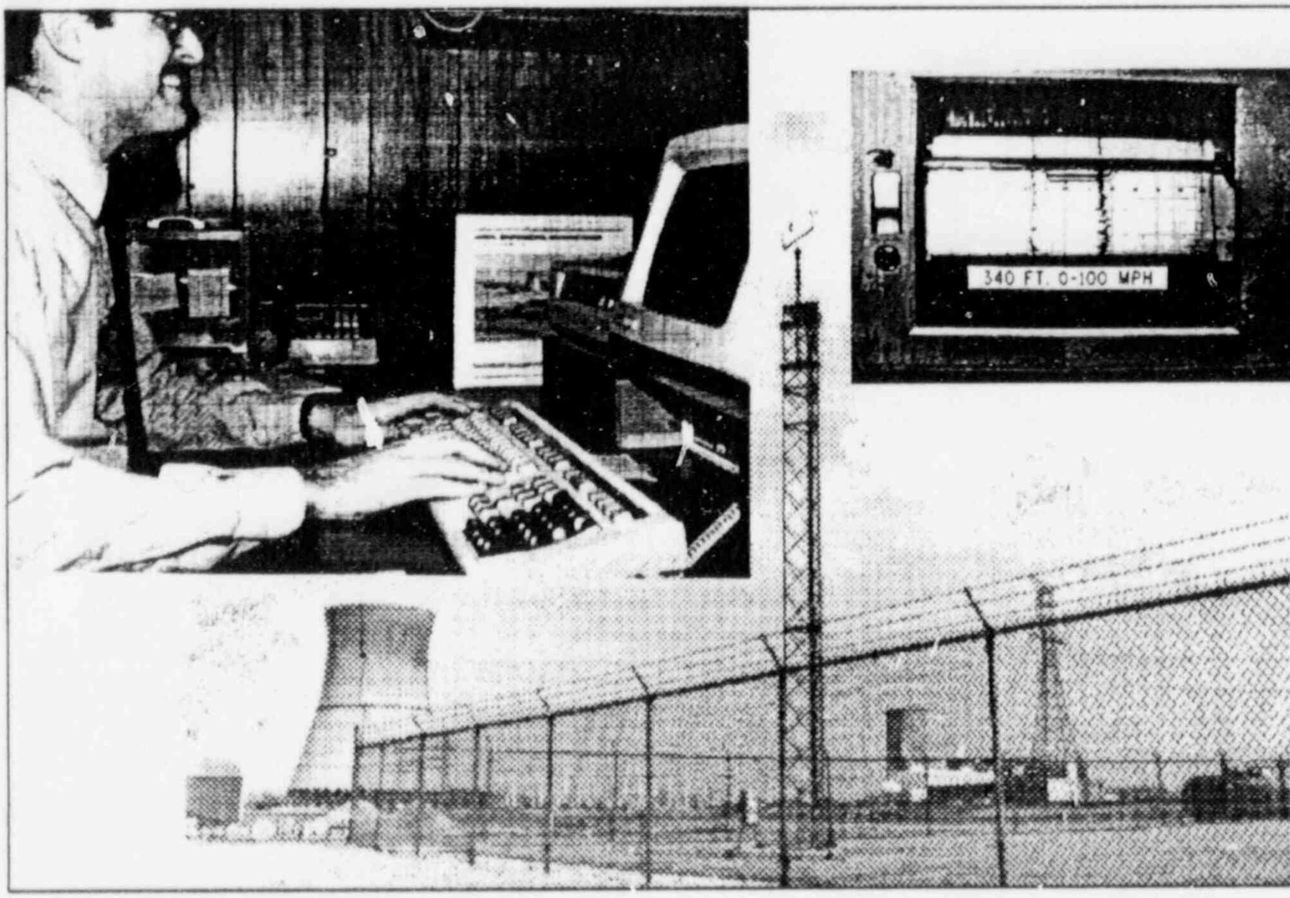



Fig 4-1: Meterological data is gathered by instruments on the weather towers (bottom), recorded by Esterline-Angus strip chart recorders (top right) and is accessed by the Davis-Besse meteorologist through the PDP 11/34 computer network (top left).

# Onsite Meteorological Monitoring

This section describes the onsite meteorological monitoring program at Davis-Besse Nuclear Power Station (DBNPS). A description of the meteorological system at Davis-Besse and data handling and analysis procedures follows. A table and discussion of the annual data recovery are also provided.

## System Description

Meteorological data collection at Davis-Besse is composed of wind speed, wind direction, sigma theta (standard deviation of wind direction), ambient (outside air) temperature, differential temperature (air temperature at one level minus air temperature at another level), dew point temperature (the air temperature where moisture begins to condense out of the air or 100% relative humidity),

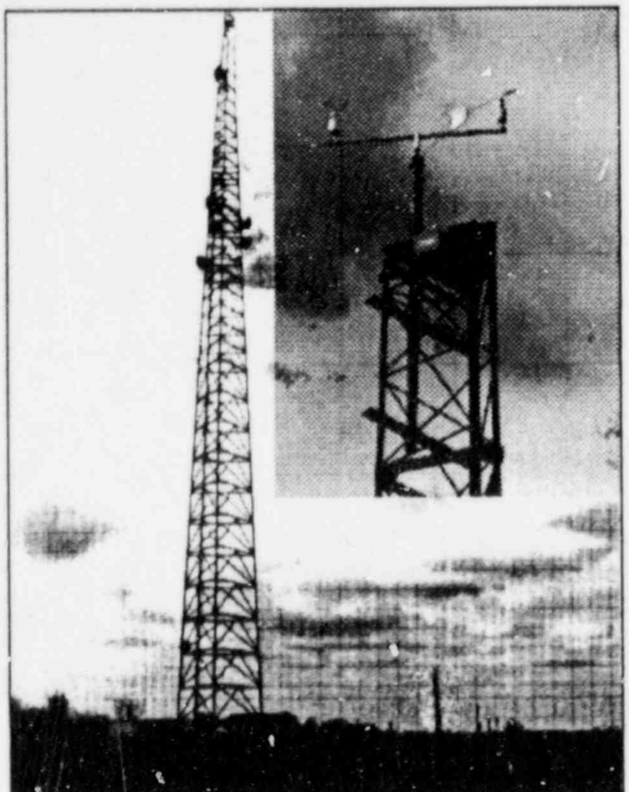


Fig. 4-2: Davis-Besse's Meteorological System includes 2 weather towers.

and precipitation. Two instrumented meteorological towers (weather towers) are used to gather data.

## Meteorological Instrumentation

The meteorological system consists of one monitoring site located at a grade level of 577 feet above mean sea level. A 340 foot free-standing tower located about 3000 feet SSW of the cooling tower and an auxiliary 35 foot tower located 100 feet west of the 340 foot tower are used to gather the meteorological data. The 340 foot tower is instrumented for wind speed and wind direction at 340 (100 meter) and 250 (75 meter) feet. The 35 foot (10 meter) tower is instrumented for wind speed and wind direction. The 340 foot tower also measures two differential temperatures (delta T's): 340-35 foot and 250-35 foot (100-10 meter and 75-10 meter). Differential temperatures are used to determine how stable or unstable the lower atmosphere is. This gives an indication of how fast effluents can be mixed and dispersed. Precipitation is measured by a tipping bucket rain gauge located near the base of the 35 foot tower. All instruments used, their location, accuracy, and thresholds are presented in Table 4-1. According to the Davis-Besse Nuclear Power Station, Operating License, Appendix A, Technical Specifications, a minimum of six instruments are required to be operable at the two lower levels (75 meter and 10 meter) to measure temperature, wind speed and wind direction.

The signals from each meteorological instrument are conditioned by translator modules located inside the meteorological shelter. These signals are then transmitted to various places: to an ADAC System-1000 computer (PDP 11/03) located in the meteorological shelter, to the control room, plant computer, and to four Esterline-Angus strip chart recorders (see figure 4-1) located in the meteorological shelter which are used if the PDP 11/03 and control room data are not available. The PDP 11/03 also communicates data to a PDP 11/34 computer located in the Davis-Besse Administration Building Technical Support

Center, and to a line printer located in the meteorological shelter. The final meteorological database is stored on the PDP 11/34.

### Meteorological System Maintenance and Calibration

Personnel at Davis-Besse inspect the meteorological site and instrumentation daily. All strip charts and data listings are removed and reviewed on a weekly basis. Tower instrumentation maintenance and quarterly calibrations are performed by NUS Corporation of Gaithersburg, Maryland.

### Meteorological Data Handling and Reduction

The PDP 11/03 in the meteorological shelter communicates instantaneous meteorological data to the PDP 11/34 in the Technical Support Center. The PDP 11/34 averages these data for each hour and stores these data in computer disk files. Missing digital data are replaced by the reduction of the strip charts where required. The data are processed and analyzed by several computer programs. Computer listings of the data are generated and values are checked for satisfying specified range and rate-of-change criteria. Summary statistics and joint frequency distributions of wind and stability data are generated and the results are reviewed for reasonableness in terms of known site characteristics and regional climatology. The end result of the review process is a validated final database suitable for use as input to atmospheric dispersion models and site meteorological characterizations.

The strip charts are logged in with parameter name, sequential chart number, chart on date, chart off date, and the date of receipt. The charts are reviewed and any problems are noted. The charts are manually reduced to give one-hour averages only on an as-needed-basis to replace missing digital data and raise data recovery. Due to chart accuracy, all wind speeds are read to the nearest one-half mile per hour. All wind directions are read to the nearest 5 degrees. All temperatures are read to the nearest 5° Fahrenheit. Differential temperatures are read to the nearest 1° Fahrenheit. The hourly precipitation totals are determined by counting the number of event marks that occurred during that hour in increments of 0.01 inches.

### Meteorological Data Recovery

The monthly and annual data recovery statistics for all parameters for 1987 are given in Table 4-2. Data recovery for 1987 was 96.71 percent or greater for all measured parameters. Data recovery for 1987 for the six instruments required to be operable was 99.03 percent or greater. Data losses during the year were as follows:

| | |
|---|---|
| February: | 10 meter dew point stuck in autobalance. |
| June: | 100 meter wind speed sensor failure. |
| July: | 100 meter wind speed and wind direction, due to lightning. |
| August: | 100 meter wind speed and wind direction, due to lightning |
| October - December: | Delta temperatures due to excess moisture in electrical junction boxes. |

Other minor losses of data were due to routine maintenance, data validation, and calibration. Table 4-2 also gives monthly and annual recovery rates for joint occurrence of wind and delta T (differential temperatures) for 1987. Annual joint recovery rates were 95.67 percent or greater for all combinations of wind and stability data and 98.94 percent or greater for the six instruments required to be operable.

## Meteorological Data Summaries

This section presents summaries of the meteorological data collected from the onsite monitoring program at Davis-Besse during 1987. Table 4-3 summarizes average and extreme values by month for wind, temperature, and precipitation data.

### Wind Speed and Wind Direction

The monthly and annual average 100m, 75m, and 10m wind speed for 1987 are given in Table 4-3. The maximum monthly average was 20.6 mph for the 100m level in November, 19.0 mph for the 75m level in November, and 12.1 mph for the 10m level in November and December. The maximum hourly average wind speeds for 1987 were 57.5 mph for the 100m level, 49.0 mph for the 75m level, and 40.5 mph for the 10m level, all occurring on December 15.

Figure 4-8 gives monthly and annual wind roses of average wind speed and percent frequency by direction for the 100m winds for 1987. The wind roses get their name because the circular pattern of each graph resembles a flowering rose. Each wind sector has two radial bars, the darker bar represents the percent of time the wind blew from that direction. The hatched bar represents the average speed of the wind from that direction. Wind direction sectors are classified using Table 4-4. Calms (less than or equal to 1.0 mph) are shown in percent in the middle of the wind rose. The 75m wind roses are given in Figure 4-9 and the 10m wind roses in Figure 4-10. On an annual basis, all levels show peak frequencies for winds from the SW and WSW, with a secondary peak for winds from the ENE. The maximum average wind speeds are for WSW and SW winds for the 100m level; WSW, SW and ENE for the 75m level; and NNW, NNE, and WSW for the 10m level. Minimum average wind speeds are for winds from the SE for the 100m and 75m levels, and from the S for the 10m level. Winds occur less frequently from the SSE and SE. The wind roses show considerable variability from month to month, but the three levels are generally similar for a given month. On an annual basis, the 100m and 75m levels show the same frequency of calms, 0.01%, with 0.13% for the 10m level. This is as expected because of the lower wind speeds at the 10m level.

Appendix G provides a listing of hourly wind directions and wind speeds at all levels for 1987.

### Atmospheric Stability

The atmospheric stability is categorized by delta T (100m - 10m) and delta T (75m - 10m) using Table 4-4. Unstable conditions (classes A-C) mix and disperse effluents better than stable conditions (classes E-G). Table 4-5 gives the monthly and annual stability class frequency distributions for 1987, based on delta T (100m - 10m). This shows that neutral and slightly stable conditions (classes D and E) were the most common during the year.

For comparison purposes, the delta T (75m - 10m) stability class frequency distribution is given in Table 4-6. The delta T (75m - 10m) shows an increase of extreme classes (A and G) and a decrease of neutral (class D) relative to the delta T (100m - 10m) distribution, as expected due to the small height separation.

Tables 4-7 and 4-8 give the distributions of stability classes by hour of day for delta T (100m - 10m) and delta T (75m - 10m), respectively, for 1987. They show, as expected, that unstable classes occur primarily during the daytime hours and stable classes generally occur at night. The neutral class occurs throughout the day and night, but shows a peak frequency for morning and afternoon transition periods. Stability persistence periods, based on delta T (100m - 10m) and delta T (75m - 10m) are given in Tables 4-9 and 4-10,

Fig. 4-3: Satellite images of the western hemisphere can be accessed to aid in identifying major storm systems which could impact plant operations.

Fig. 4-4: Satellite images of North America can be accessed to aid in planning and scheduling of plant maintenance and operations as well as severe or unusual weather identification.

FIGURE 4-3

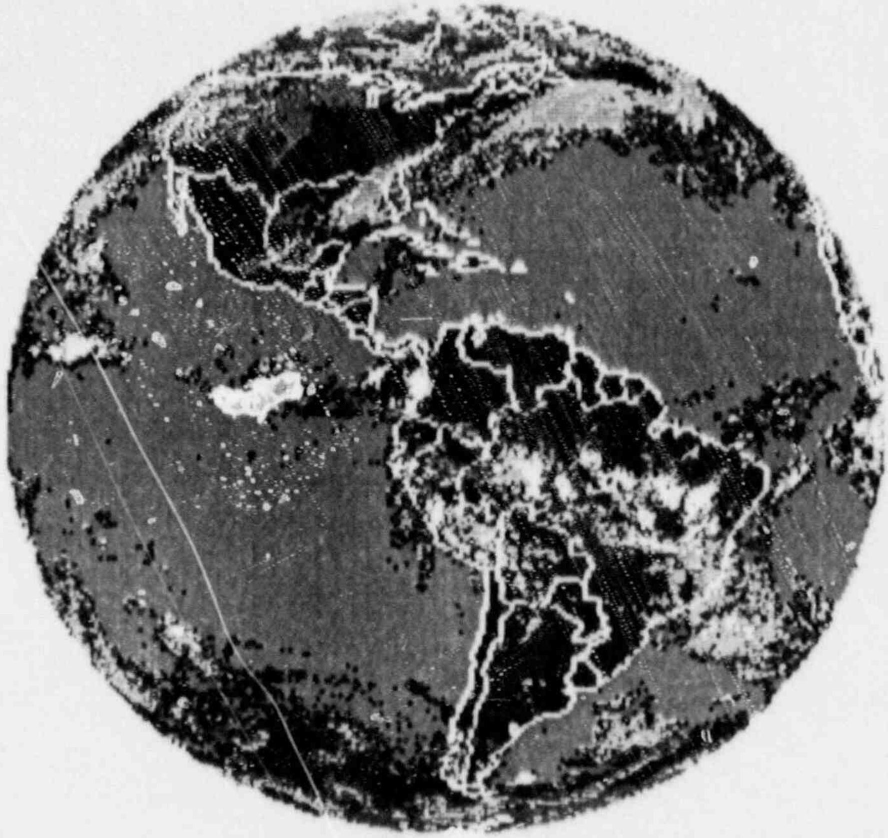
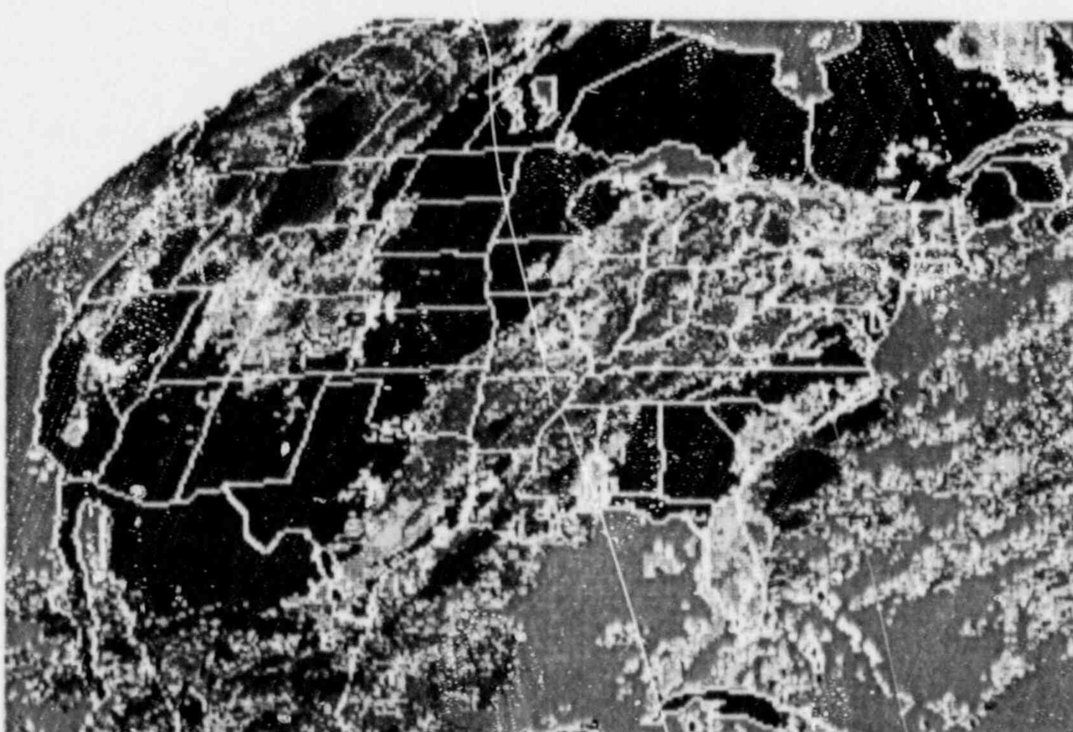


FIGURE 4-4



respectively. The longest period of persistence was 103 hours for delta T (100m - 10m) and 115 hours for delta T (75m - 10m), all for stability class D. The longest period of persistence for any other class was 28 hours for delta T (100m - 10m) and 39 hours for delta T (75m - 10m), all for stability class E.

Appendix G provides a listing of hourly delta T (100m-10m and 75m-10m) values for 1987.

### Ambient Temperature

Monthly average and extreme temperatures for 1987 are given in Table 4-3. These data are measured at the 10m level. The maximum monthly average temperature was 75.7$^{\circ}$F for July. The minimum monthly average temperature was 27.3$^{\circ}$F for January. The extreme maximum was 93.0$^{\circ}$F on August 2, and the extreme minimum was -3.3$^{\circ}$F on January 24.

Appendix G provides a listing of hourly 10 meter temperatures for 1987.

### Dew Point Temperature

Monthly average and extreme dew point temperatures for 1987 are given in Table 4-3. These data are measured at the 10m level. The maximum monthly average dew point temperature was 67.1$^{\circ}$F for July. The minimum monthly average dew point temperature was 21.1$^{\circ}$F for January. The extreme maximum was 77.4$^{\circ}$F on July 20, and the extreme minimum was -11.2$^{\circ}$F on January 24.

Appendix G provides a listing of hourly 10 meter dew point temperatures for 1987.

### Precipitation

Monthly totals and extremes of precipitation at Davis-Besse for 1987 are given in Table 4-3. Total precipitation for the year was 33.90 inches. The maximum daily precipitation total was 2.87 inches which occurred on June 20. The maximum one-hour total precipitation was 0.77 inches, on June 19. It is likely that precipitation totals in colder months are somewhat less than the actual amounts received at the site due to periods of freezing precipitation coupled with strong winds. Appendix G provides a listing of hourly precipitation values for 1987.

# Monthly and Annual Comparison of Local Climatological Data

Meteorological data from Toledo Express Airport and Cleveland Hopkins International Airport were compared to Davis-Besse meteorological data on an annual and monthly basis for 1987.

## Description of Monitoring Locations

Toledo Express Airport is located 20 miles inland and southwest of Lake Erie at latitude 41°36'N and longitude 83°48'W. The temperature sensor is located at 2 meters above ground level and the wind speed sensor is located at 10 meters above ground level. Both sensors are located in generally level and open terrain.

Cleveland Hopkins International Airport is located 5 miles inland and south of Lake Erie at latitude 41°25'N and longitude 81°52'W. The temperature sensor is located at 2 meters above ground level and the wind speed sensor is located 10 meters above ground level. Both sensors are located in gently rolling and open terrain.

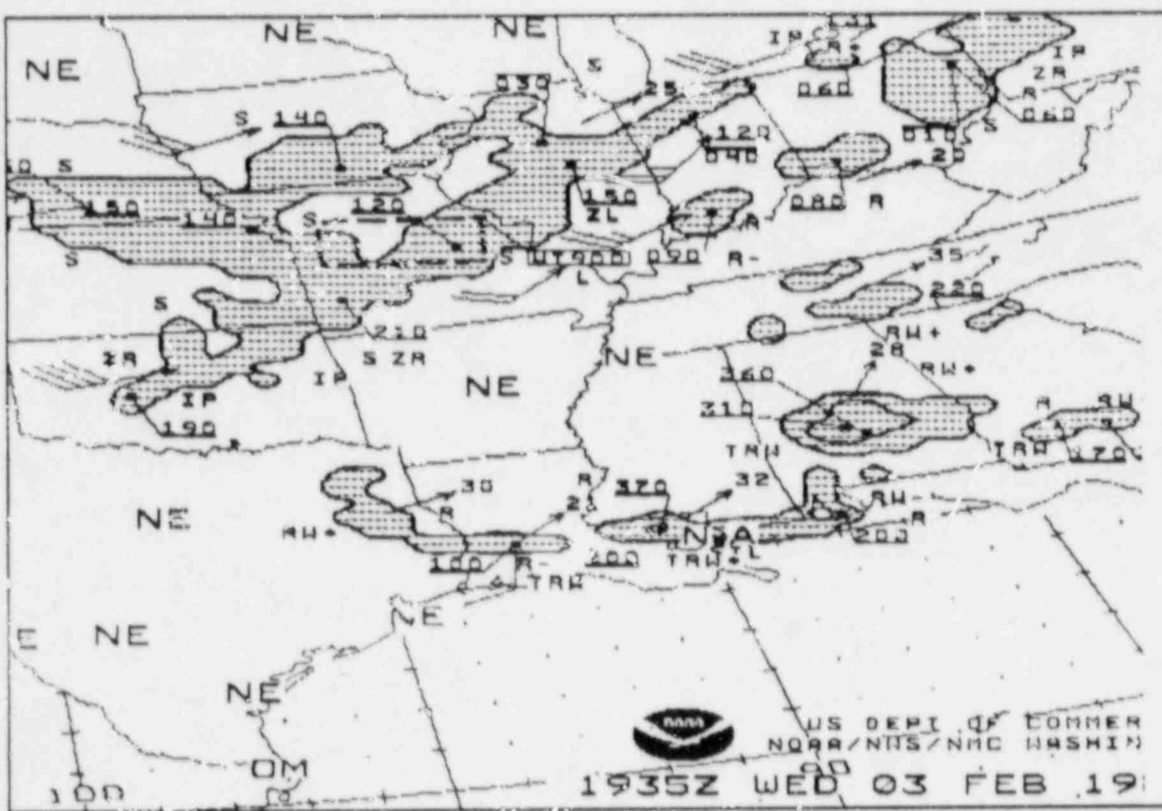



Fig. 4-5: Davis-Besse also has access to national and worldwide weather displays and data such as this radar depiction.

Davis-Besse's meteorological tower is located one mile inland from Lake Erie at latitude 41°36'N and longitude 83°05'W. Temperature and wind speed sensors are located 10 meters above ground level in level and open terrain.

## Site Comparisons

Most of the differences between the three sites are a result of their proximity to Lake Erie. Lake Erie moderates the temperature near the shore, and also affects the wind because of lake/land breezes. Davis-Besse is located closest to the lake, and is influenced more than Cleveland or Toledo.

Table 4-11 gives monthly and annual summaries for Toledo, Davis-Besse, and Cleveland meteorological data. Table 4-11 shows the maximum and minimum temperatures, the average maximum and minimum temperatures, the average range between average maximum and minimum temperatures, total precipitation, number of days where at least 0.01 inches fell, and the average wind speed.

The maximum temperature in each month and the average of all maximum temperatures in each month were usually lowest at Davis-Besse. The minimum temperature in each month and the average of all minimum temperatures in each month were usually highest at Davis-Besse. Thus, because Davis-Besse is closest to Lake Erie, it was not as hot during the day and not as cold during the night compared with Toledo and Cleveland. The range between the maximum and minimum, as well as the average range between the average maximum and minimum show that Toledo had the higher temperature range. Thus, because Toledo is farthest from Lake Erie, it was hotter during the day and colder during the night compared with Davis-Besse and Cleveland. The moderation of temperature due to Lake Erie is slightly less during the winter months when the ice cover tends to insulate Lake Erie.

Since Davis-Besse is closest to Lake Erie, average wind speeds are faster at Davis-Besse than Toledo or Cleveland. Friction due to trees, terrain, buildings, and other features on land causes wind speeds over land to be slower than the wind speeds over Lake Erie. Wind flow coming off Lake Erie thus tends to be higher at Davis-Besse causing the average speeds at Davis-Besse to be higher.

Cleveland received more precipitation throughout the year because it lies downwind from Lake Erie. The prevailing wind, from the southwest and west-southwest, blows moist air off Lake Erie over Cleveland. Lake enhanced snowfall is also much greater at Cleveland.

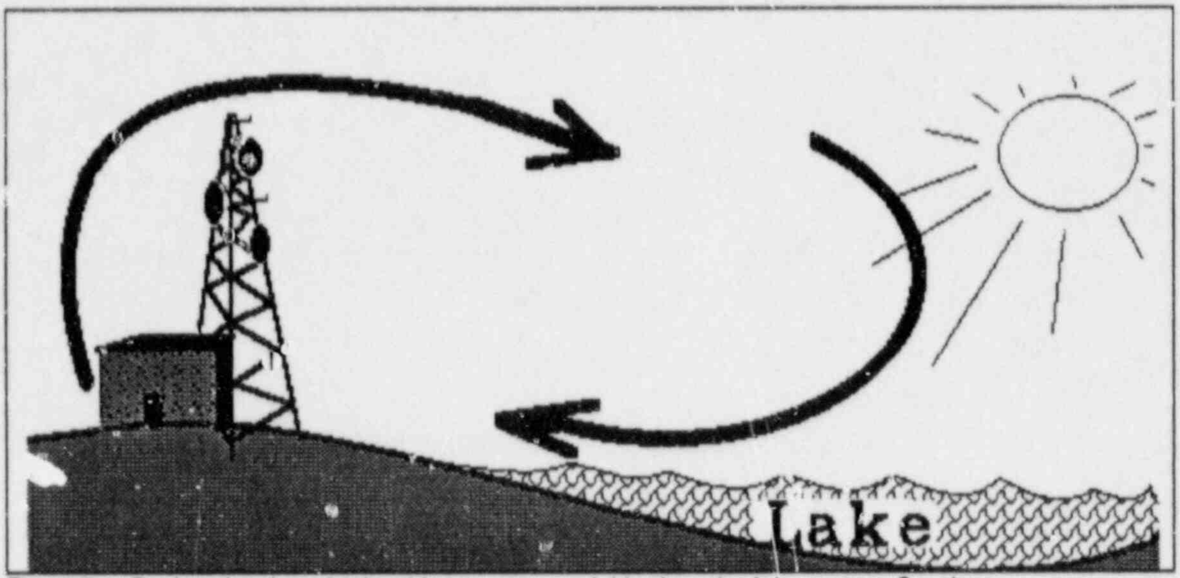



Fig. 4-6: During the day, the land heats more quickly than the lake water. So, the warm air over the land rises, while the cool air over the lake sinks. This causes the wind to blow inland.

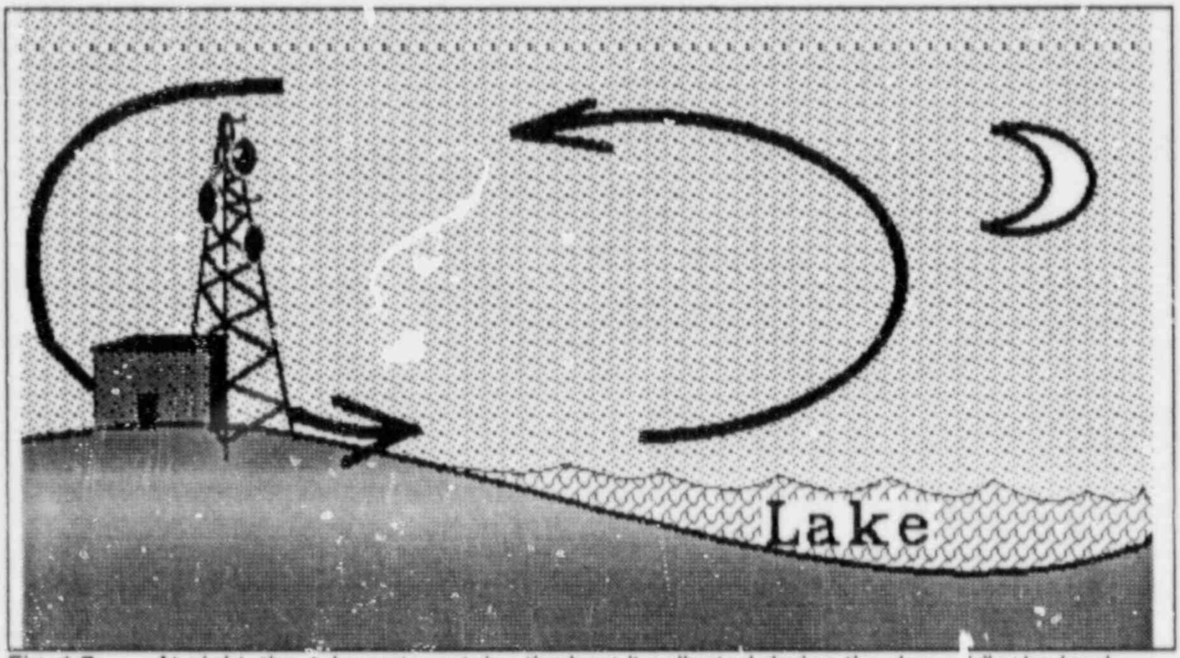



Fig. 4-7: At night, the lake water retains the heat it collected during the day, while the land cools rapidly. This causes the air over the lake to become warm and rise, while that over the land cools and sinks. Thus, the wind blows out, over the lake.

# Lake/Land Breeze Study

Heating and cooling cycles that develop from solar heating of the atmosphere can create several localized wind systems. The onshore (lake) and offshore (land) breezes near Lake Erie at Davis-Besse are a good example. Lake Erie causes the temperature of the air over the water to be quite different compared with the air temperature over the land. During the daytime the land surface heats faster than the water and reaches higher temperatures because of the different thermal characteristics of land and water.

Warmer air above the land rises faster because it is less dense than air over Lake Erie. This leads to rising air currents over the land with descending denser air over the Lake. This starts a wind circulation which draws air from the water to the land during the daytime causing a lake breeze.

At night, the water retains its heat as the land cools rapidly. This results in warmer, less dense air over the Lake with colder air over the land causing the local winds to shift from the land to the water resulting in a land breeze.

The lake/land breeze circulation at Davis-Besse is generally not present during the late fall, winter, and early spring or when skies are cloudy due to the loss of strong solar heating of the land. The lake/land breeze is also not present when the difference between the lake temperature and land temperature is too-small, or when wind speeds become faster than 12 mph which tend to destroy the circulation and indicate that the large scale weather features (fronts, lows, highs, etc.) are more dominant.

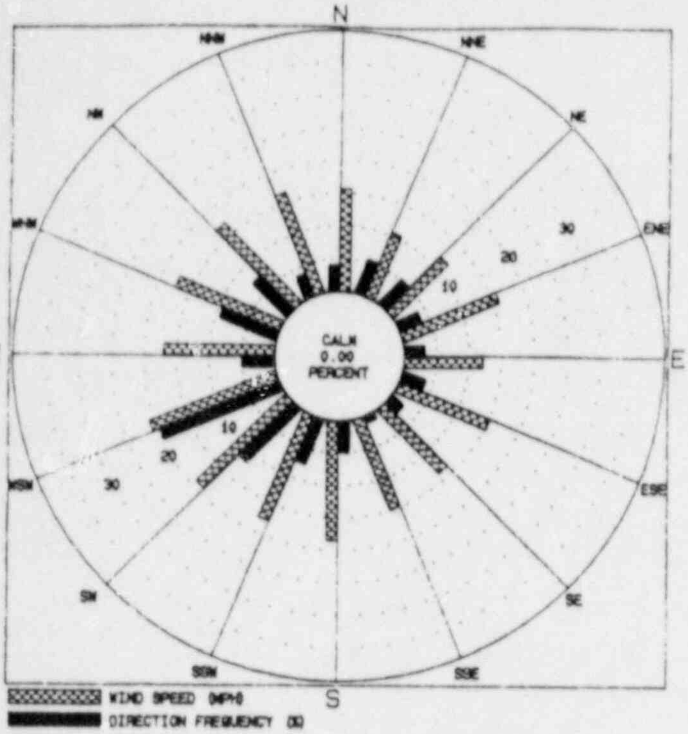
To study the lake/land breezes at Davis-Besse, each wind monitoring level was averaged on a monthly and annual basis during times when wind speeds at the 10m level were 10 mph or less for the daytime hours only, the nighttime hours only, and all hours of the day. This 10 mph restriction serves to screen obvious cases where a lake/land breeze is not present. For comparison purposes, all speeds and all hours of the day were also averaged at each wind monitoring level. Table 4-12 shows the most common (predominant) wind direction at each monitoring level on a monthly and annual basis for 1987 for these various averaging techniques. The purpose of examining the data during various times of the day is to highlight any effects that Lake Erie may have upon wind patterns at Davis-Besse.

Table 4-12 shows that for all speeds and all hours at each level, and even for all hours where speeds were 10 mph or less, easterly and northeasterly flow predominated from late winter through spring while the rest of the year flow from west-southwest through south-southwest predominated. The effect of Lake Erie is quite visible when the daytime and nighttime predominant wind directions (where the wind speed is 10 mph or less) are compared. May and June indicate significant flow reversals between daytime and nighttime. Winds were from the east or east-northeast during the day indicating a lake breeze and from the south-southwest or southwest during the night, indicating a land breeze. The effect is more pronounced in May than in June. November also indicates a flow reversal between daytime and nighttime, but only at the 10m level. Due to the small number of times where wind speeds were below 10 mph during November, as well as a lack of strong solar heating in November, this flow reversal is probably not indicative of a lake/land breeze. Table 4-12 does not show the less significant flow reversals that also occurred in July and August.

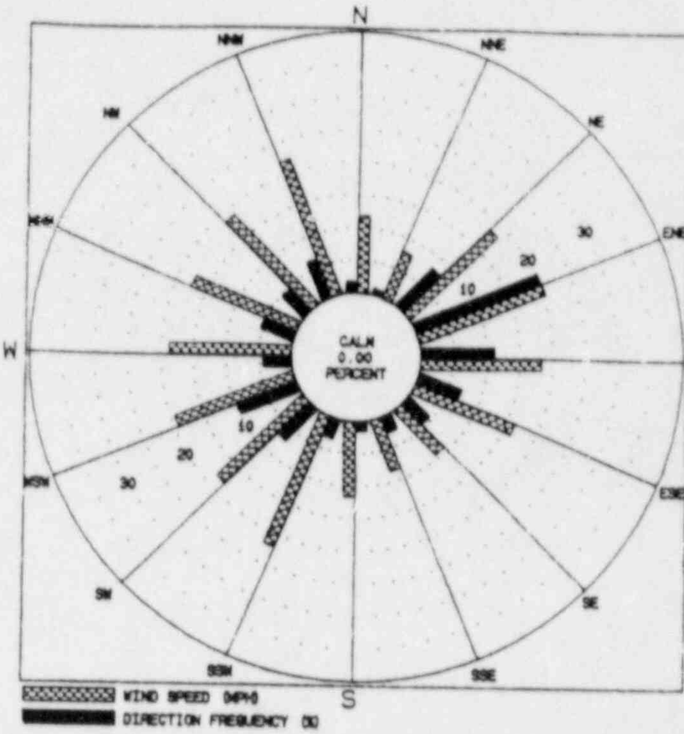
In general, lake/land breezes occurred at Davis-Besse from May through August with a peak in May. Lake breezes occur during the day with flow from the east and east-northeast and land breezes occur during the night with flow from the south-southwest and southwest. This study prepares Davis-Besse personnel for the possibility of wind shifts due to lake/land breezes which can rapidly change dispersion patterns at the site.

FIGURE 4-8

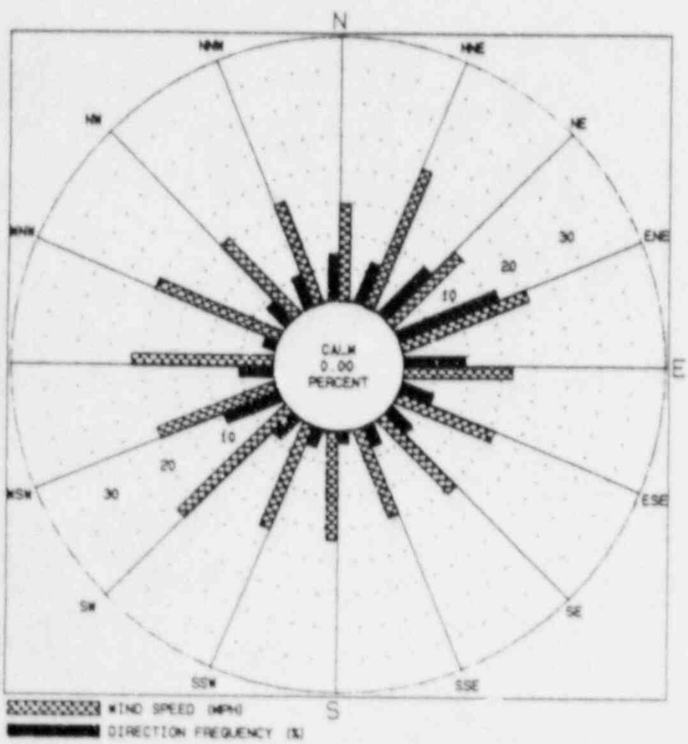
DAVIS-BESSE NUCLEAR POWER STATION
100m WIND ROSES JANUARY THROUGH DECEMBER 1987



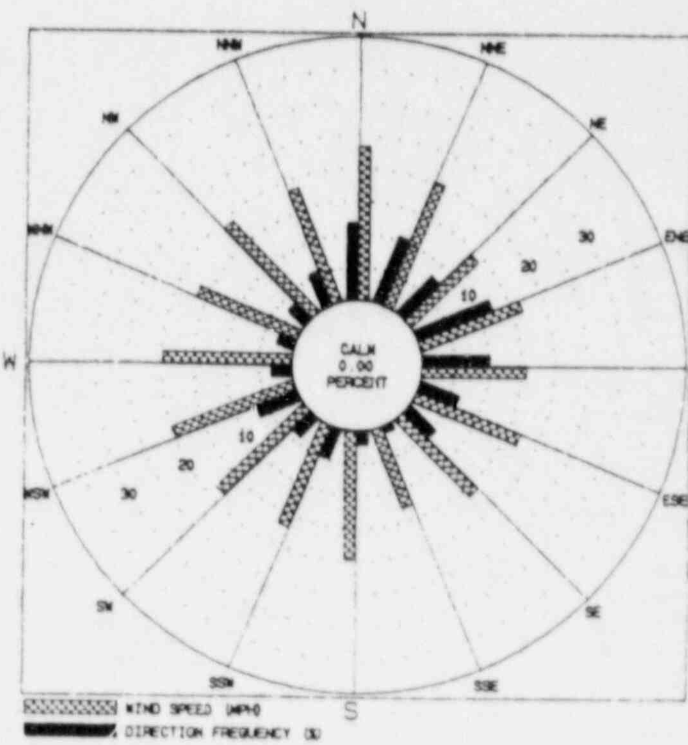

DAVIS BESSE
JANUARY 1987
100M LEVEL




DAVIS BESSE
FEBRUARY 1987
100M LEVEL



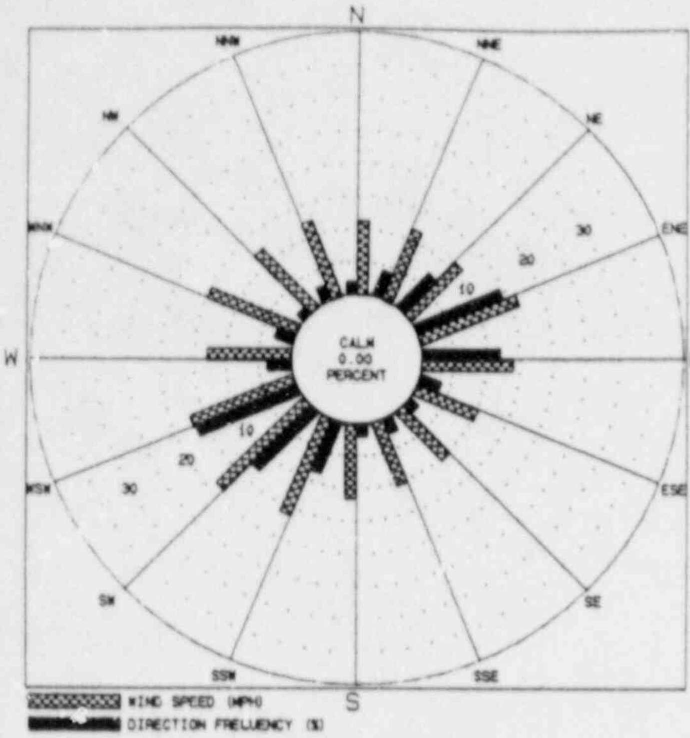

DAVIS BESSE
MARCH 1987
100M LEVEL



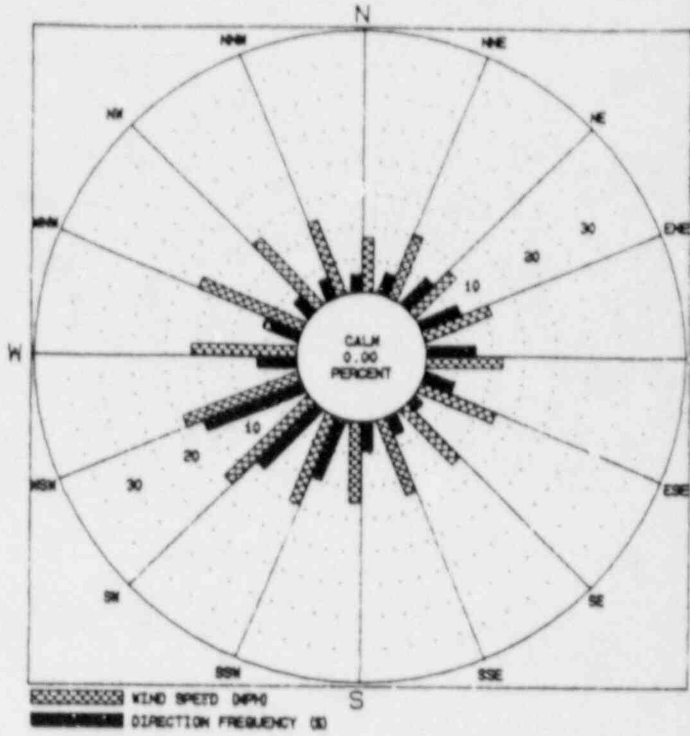

DAVIS BESSE
APRIL 1987
100M LEVEL

FIGURE 4-8 (continued)

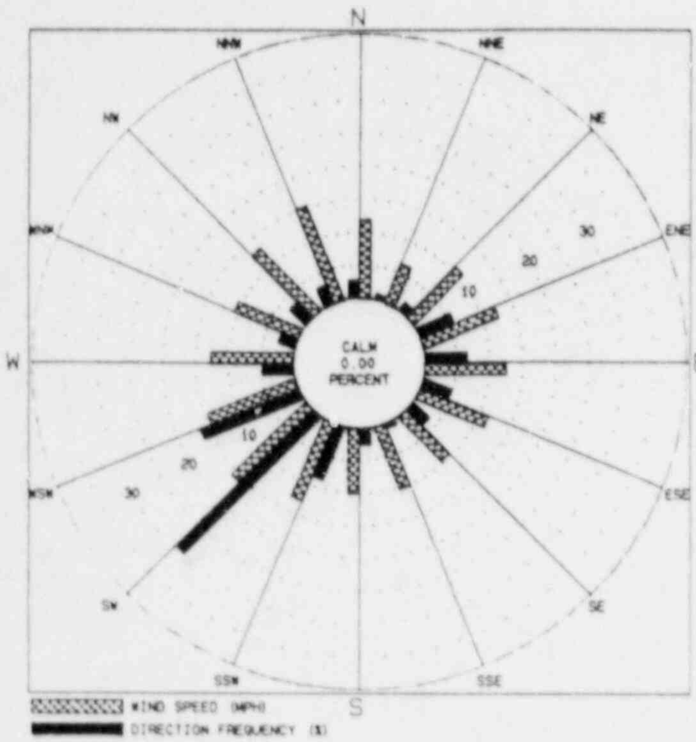
DAVIS-BESSE NUCLEAR POWER STATION
100m WIND ROSES JANUARY THROUGH DECEMBER 1987



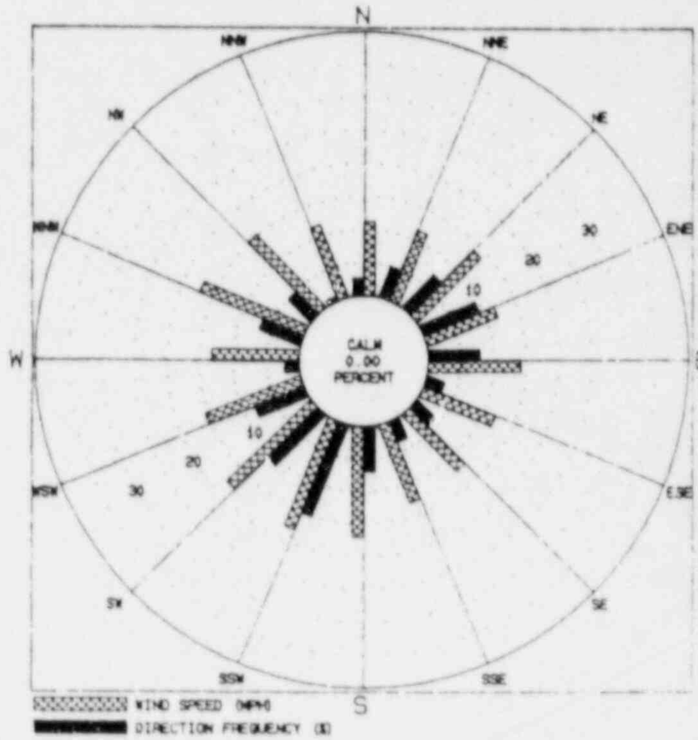

DAVIS BESSE
MAY 1987
100M LEVEL




DAVIS BESSE
JUNE 1987
100M LEVEL



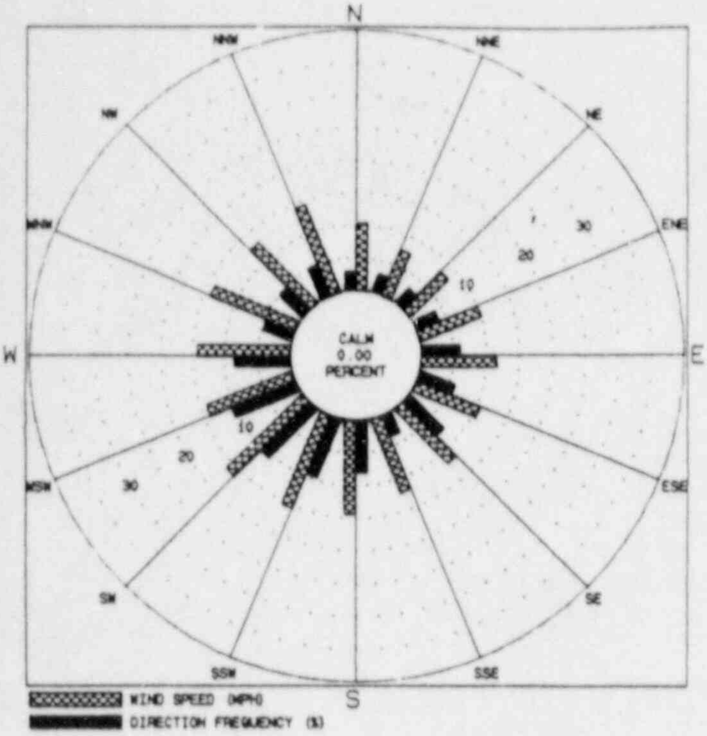

DAVIS BESSE
JULY 1987
100M LEVEL



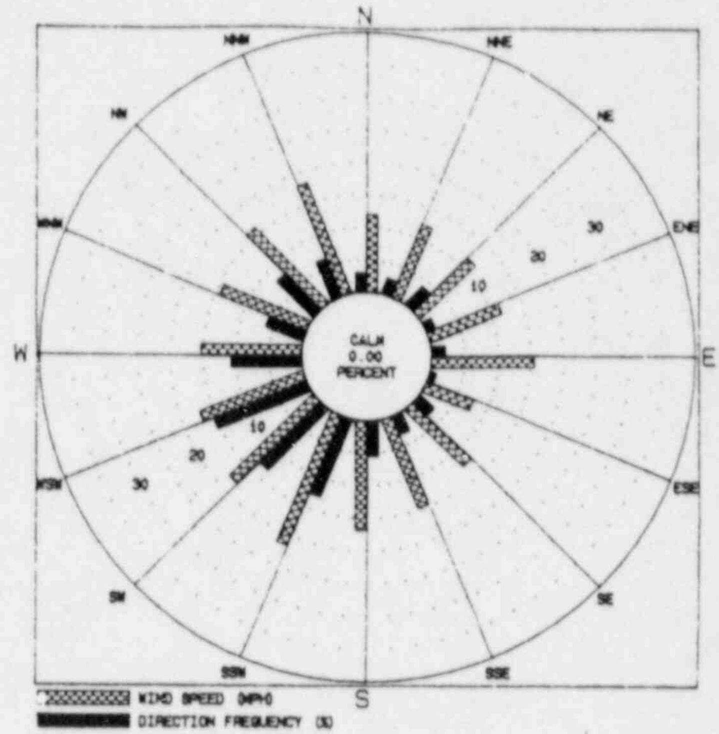

DAVIS BESSE
AUGUST 1987
100M LEVEL

FIGURE 4-8 (continued)

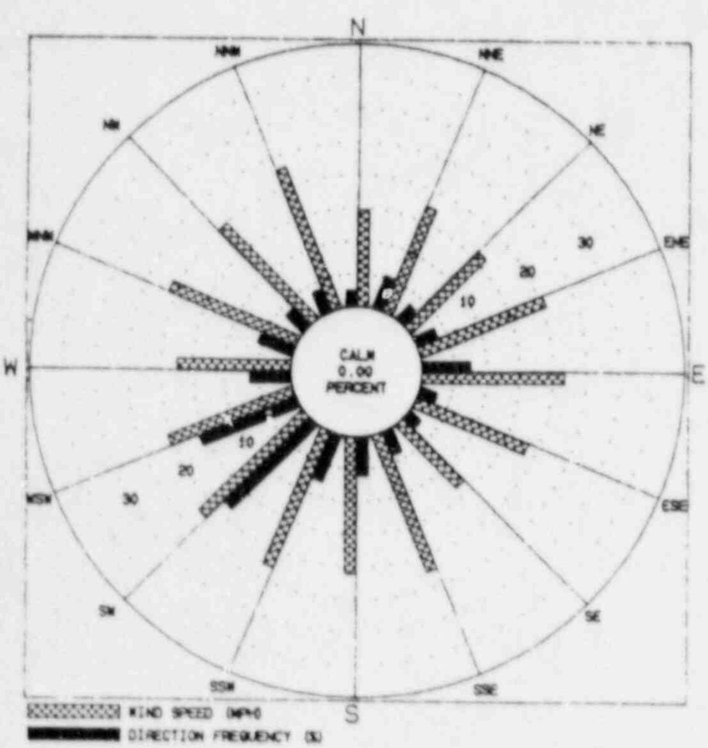
DAVIS-BESSE NUCELAR POWER STATION
100m WIND ROSES JANUARY THROUGH DECEMBER 1987



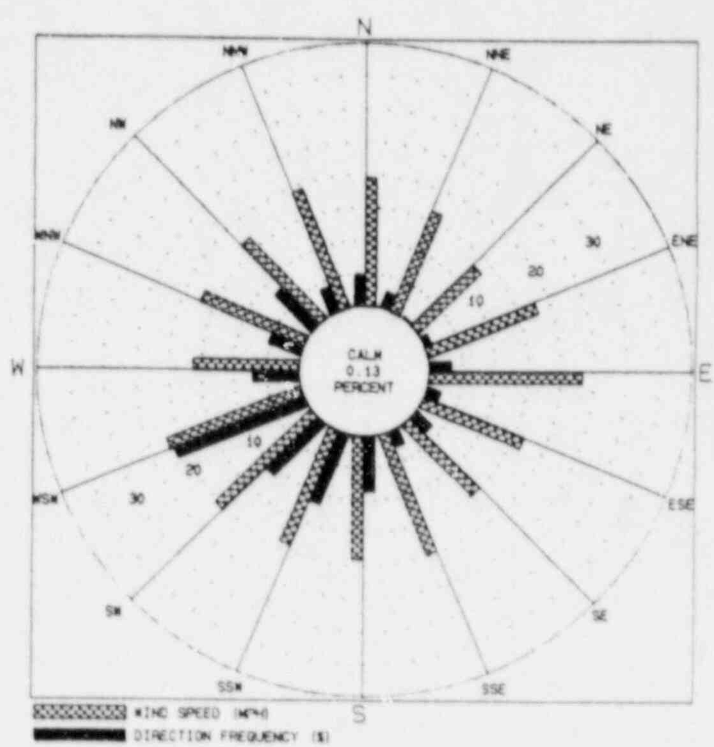

DAVIS BESSE
SEPTEMBER 1987
100M LEVEL




DAVIS BESSE
OCTOBER 1987
100M LEVEL



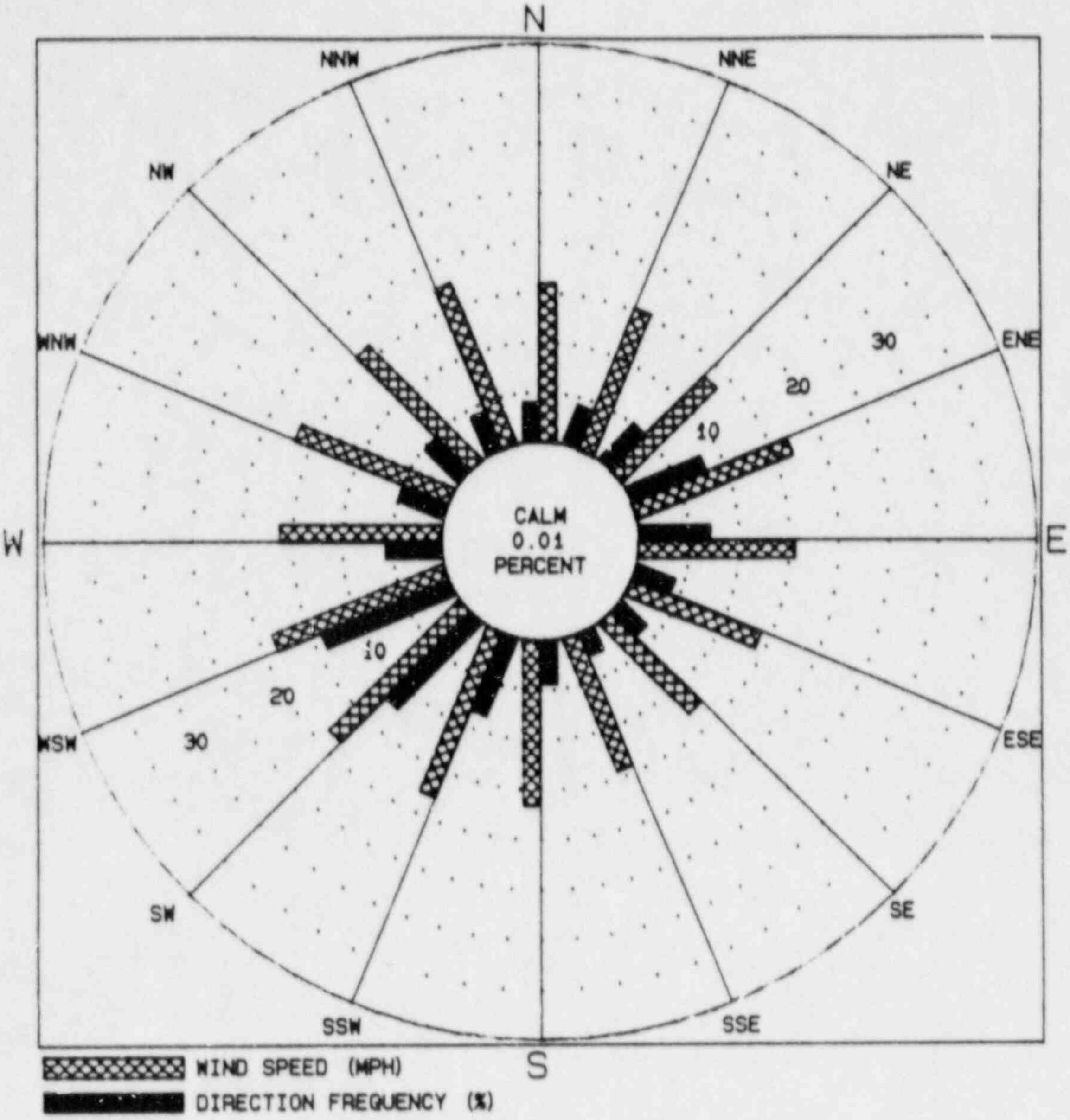

DAVIS BESSE
NOVEMBER 1987
100M LEVEL




DAVIS BESSE
DECEMBER 1987
100M LEVEL

FIGURE 4-8 (continued)

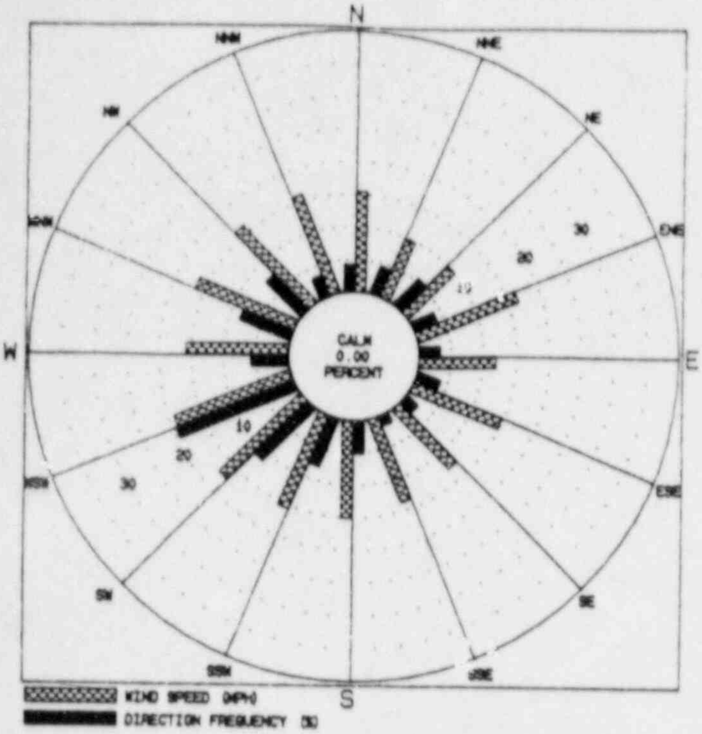
DAVIS-BESSE NUCLEAR POWER STATION
100m WIND ROSES JANUARY THROUGH DECEMBER 1987



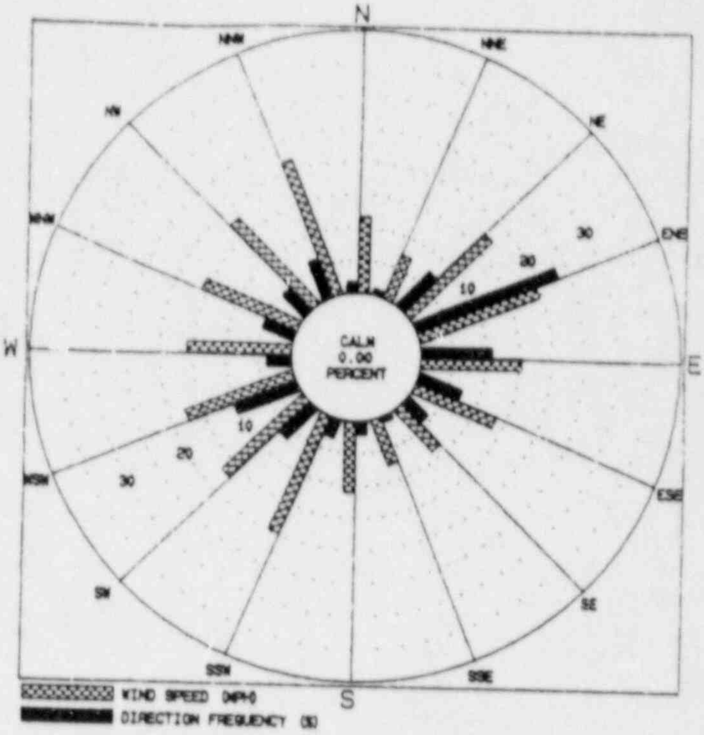

DAVIS BESSE
ANNUAL 1987
100M LEVEL

FIGURE 4-9

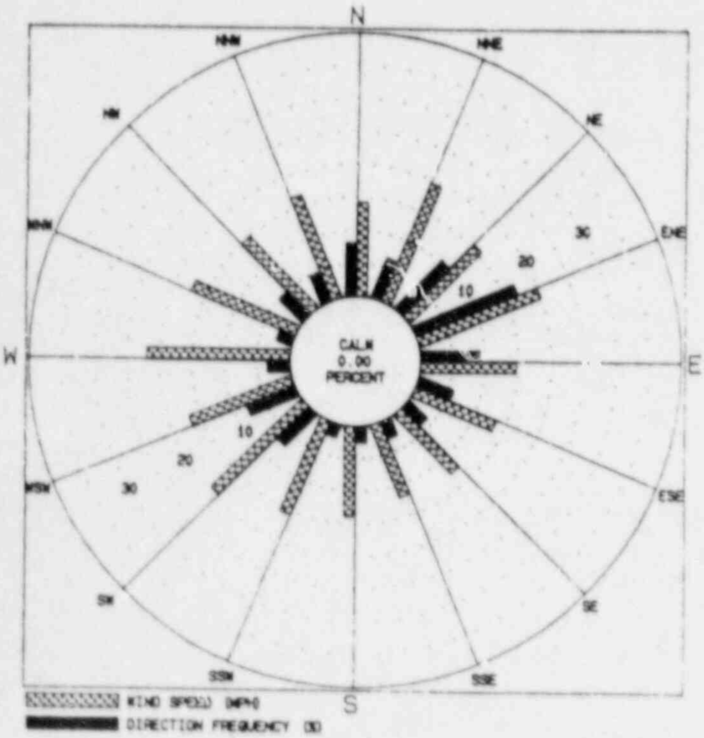
DAVIS-BESSE NUCLEAR POWER STATION
75m WIND ROSES JANUARY THROUGH DECEMBER 1987



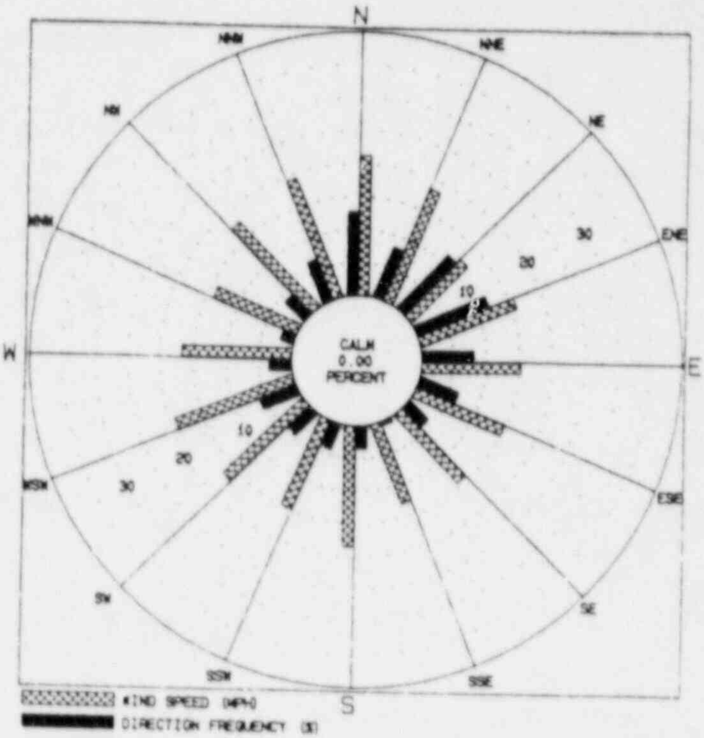

DAVIS BESSE
JANUARY 1987
75M LEVEL




DAVIS BESSE
FEBRUARY 1987
75M LEVEL



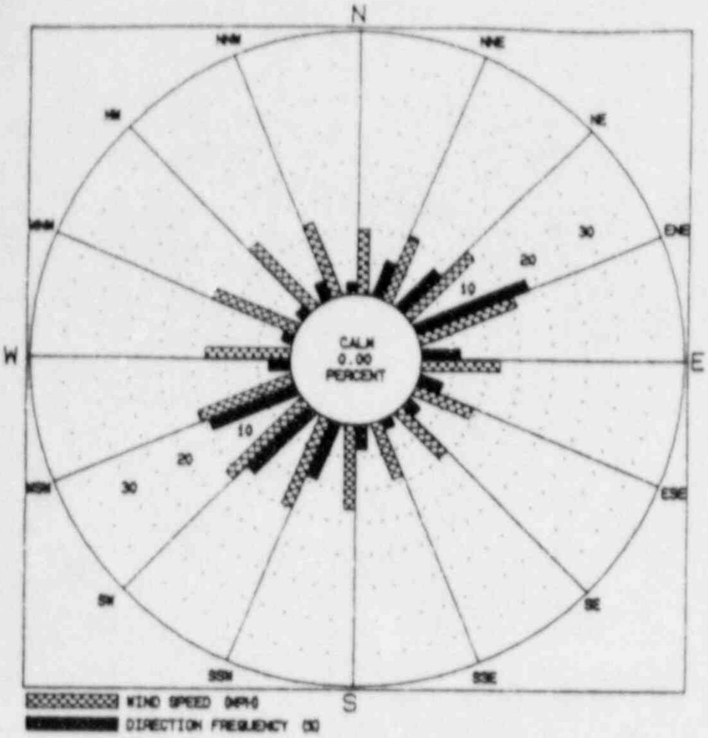

DAVIS BESSE
MARCH 1987
75M LEVEL



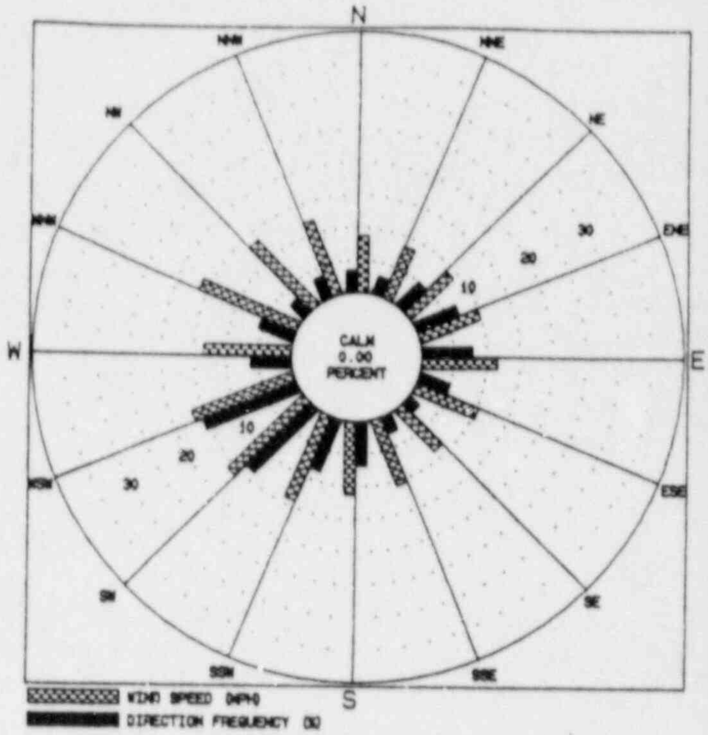

DAVIS BESSE
APRIL 1987
75M LEVEL

FIGURE 4-9 (continued)

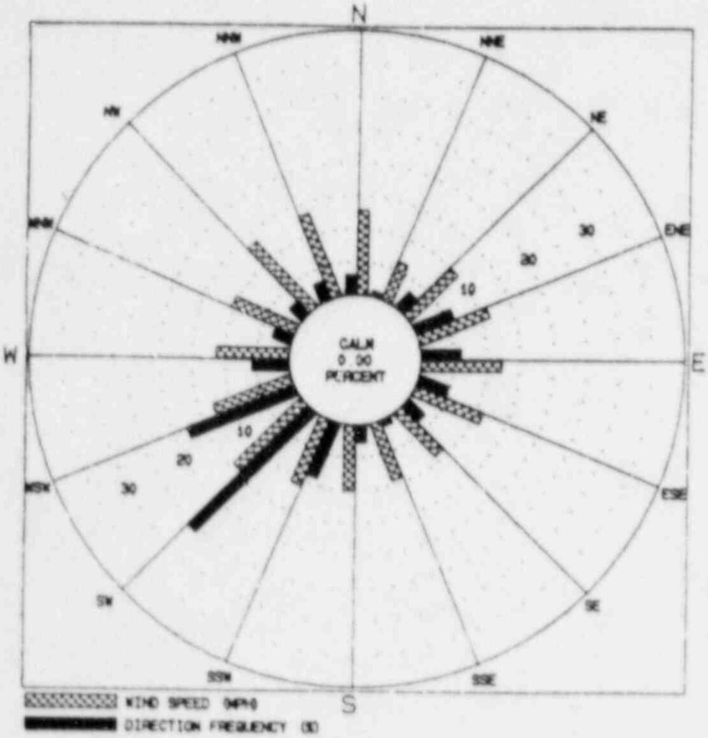
DAVIS-BESSE NUCLEAR POWER STATION
75m WIND ROSES JANUARY THROUGH DECEMBER 1987



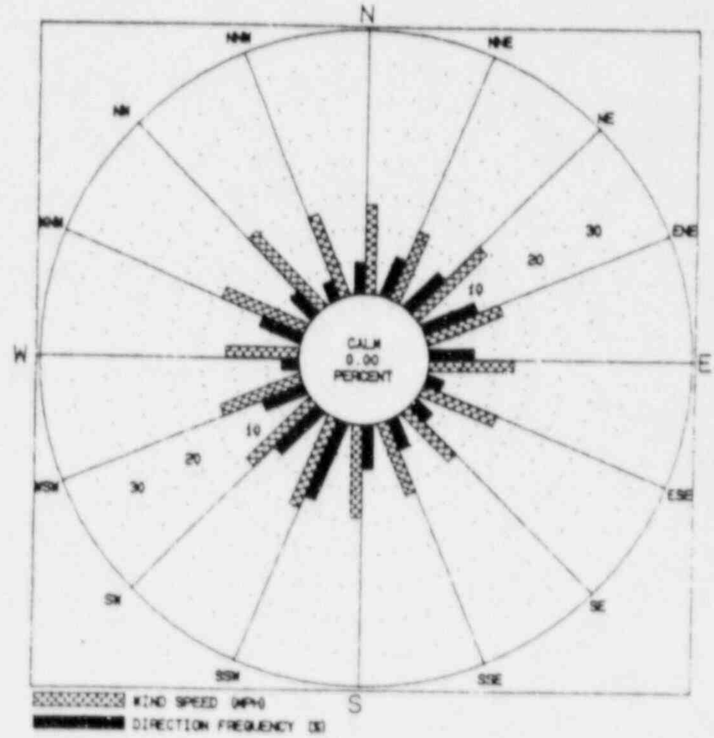

DAVIS BESSE
MAY 1987
75M LEVEL




DAVIS BESSE
JUNE 1987
75M LEVEL



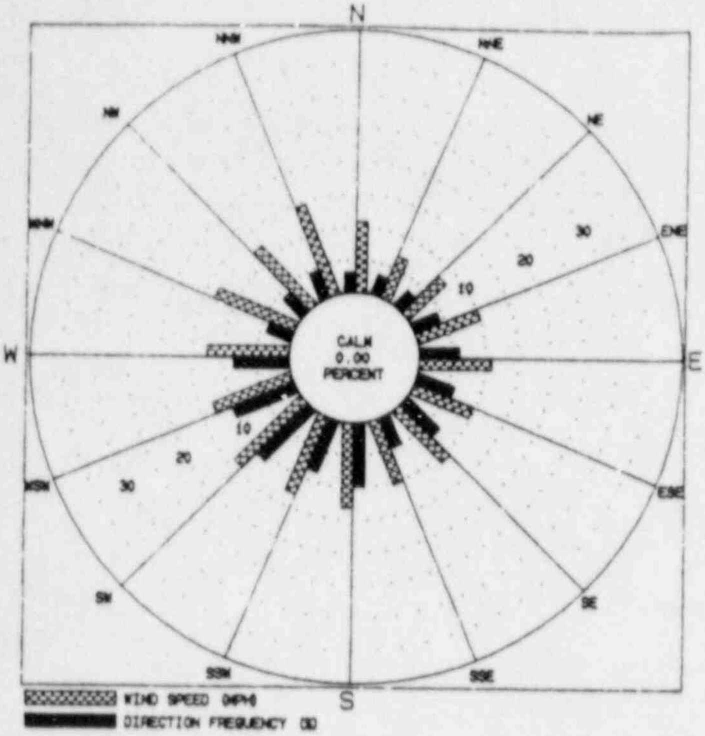

DAVIS BESSE
JULY 1987
75M LEVEL



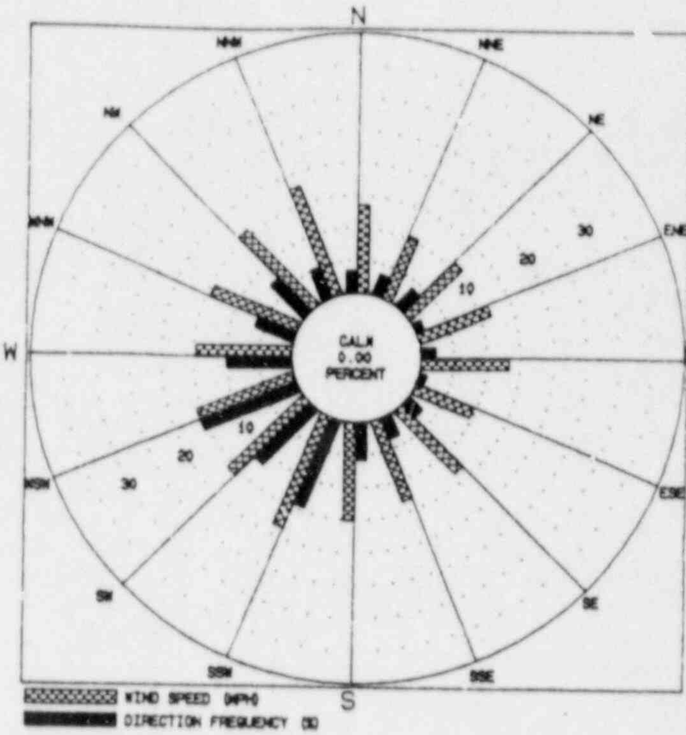

DAVIS BESSE
AUGUST 1987
75M LEVEL

FIGURE 4-9 (continued)

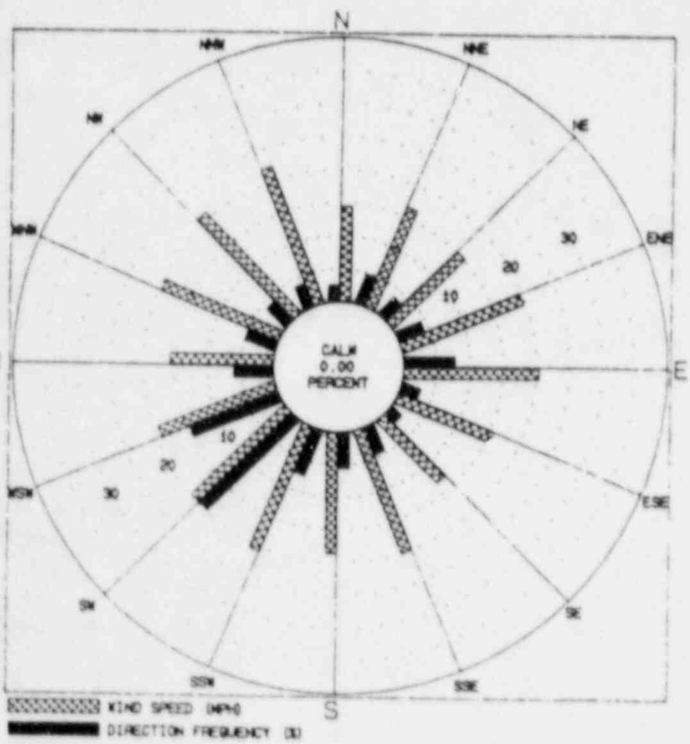
DAVIS-BESSE NUCLEAR POWER STATION
75m WIND ROSES JANUARY THROUGH DECEMBER 1987



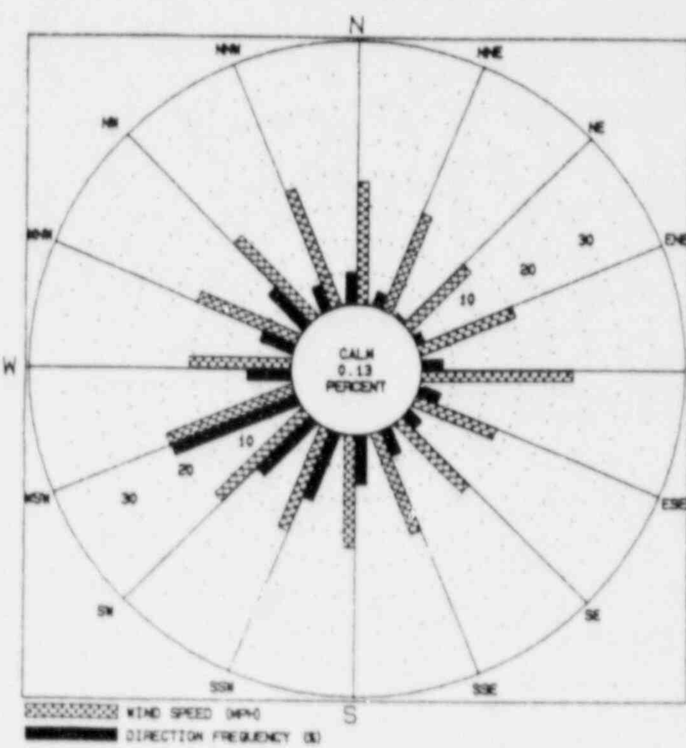

DAVIS BESSE
SEPTEMBER 1987
75M LEVEL




DAVIS BESSE
OCTOBER 1987
75M LEVEL



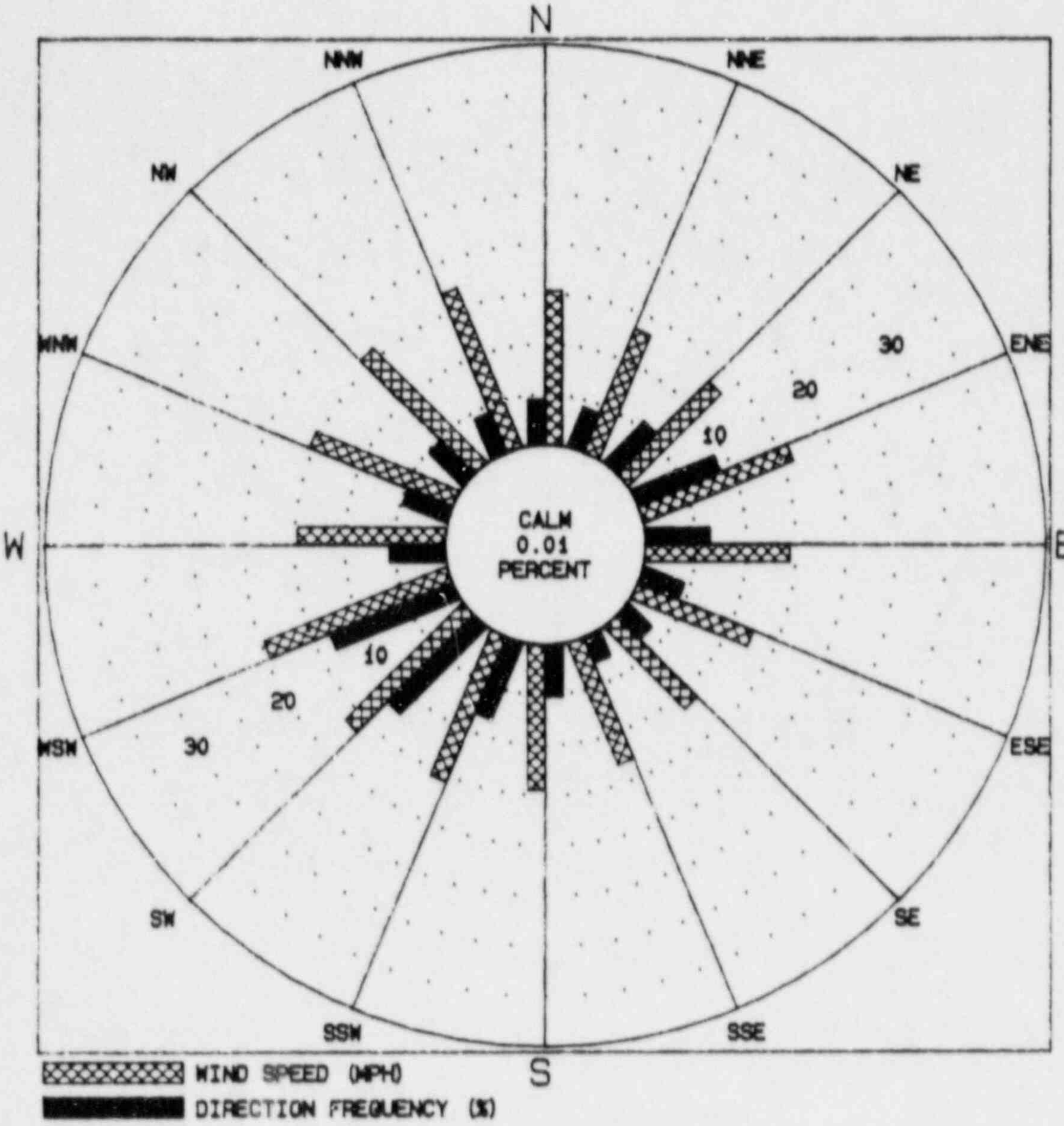

DAVIS BESSE
NOVEMBER 1987
75M LEVEL




DAVIS BESSE
DECEMBER 1987
75M LEVEL

FIGURE 4-9 (continued)

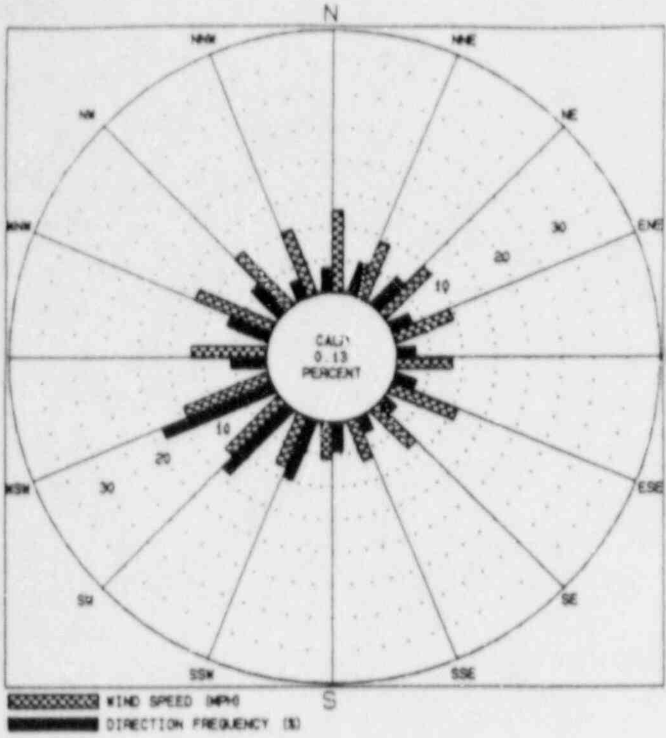
DAVIS-BESSE NUCLEAR POWER STATION
75m WIND ROSES JANUARY THROUGH DECEMBER 1987



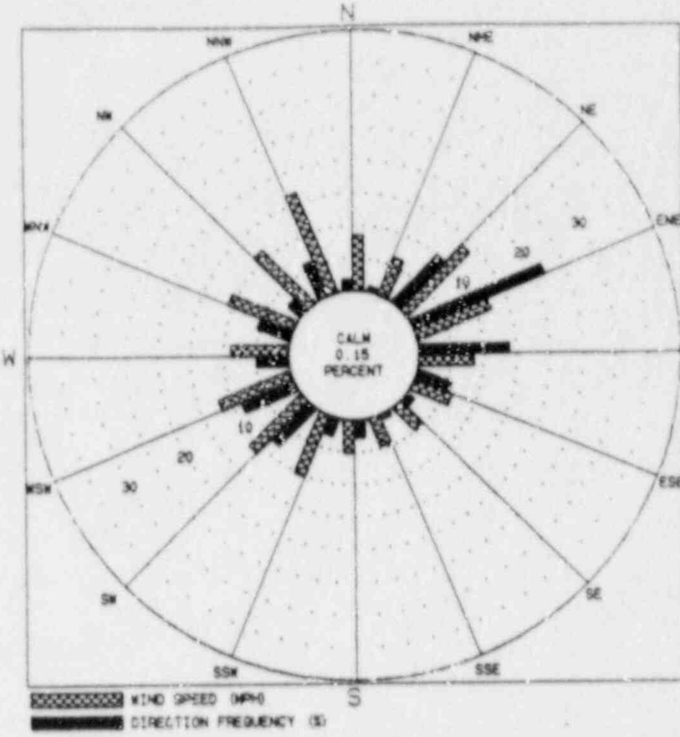

DAVIS BESSE
ANNUAL 1987
75M LEVEL

FIGURE 4-10

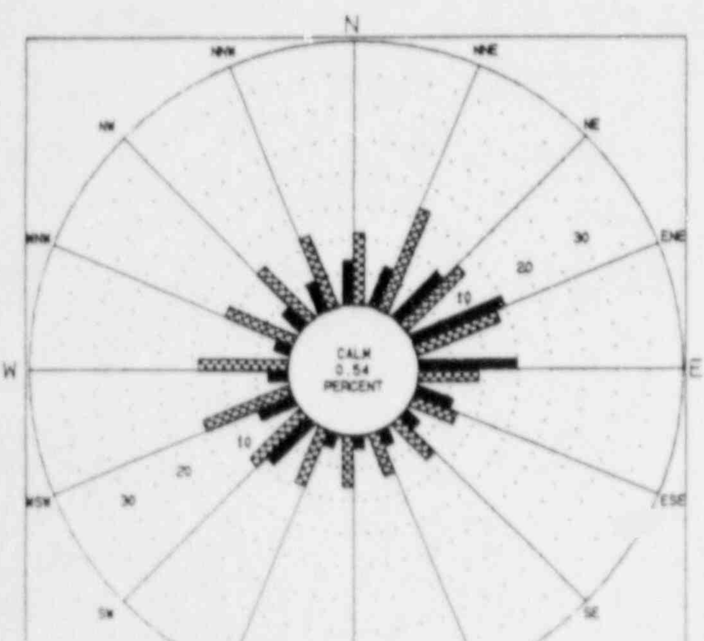
DAVIS-BESSE NUCLEAR POWER STATION
10m WIND ROSES JANUARY THROUGH DECEMBER 1987



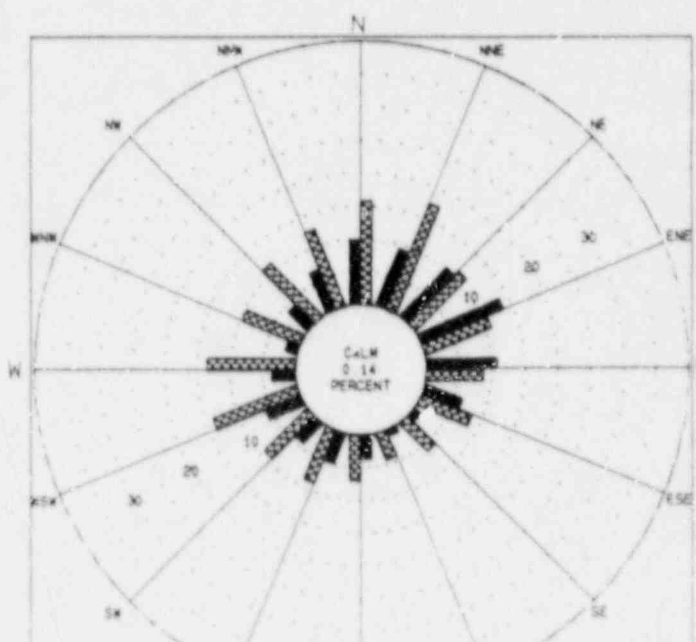

DAVIS BESSE
JANUARY 1987
10M LEVEL




DAVIS BESSE
FEBRUARY 1987
10M LEVEL



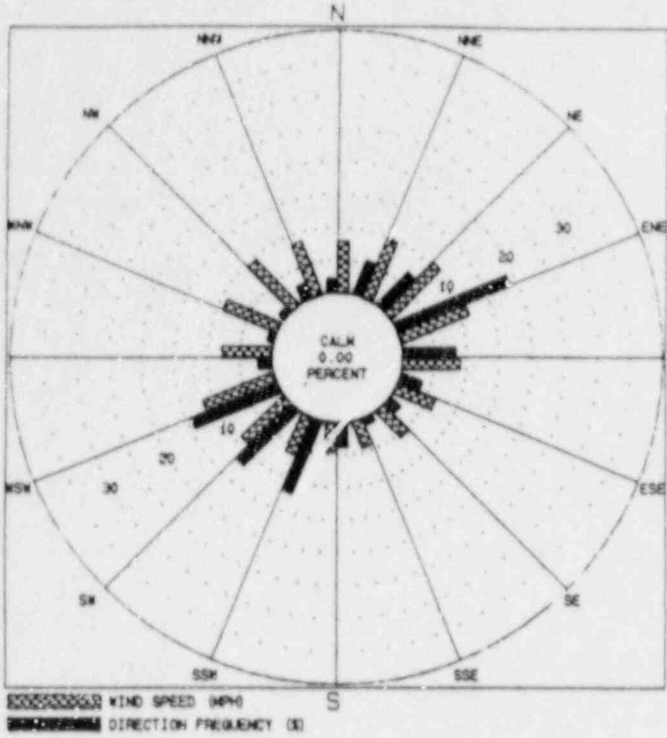

DAVIS BESSE
MARCH 1987
10M LEVEL



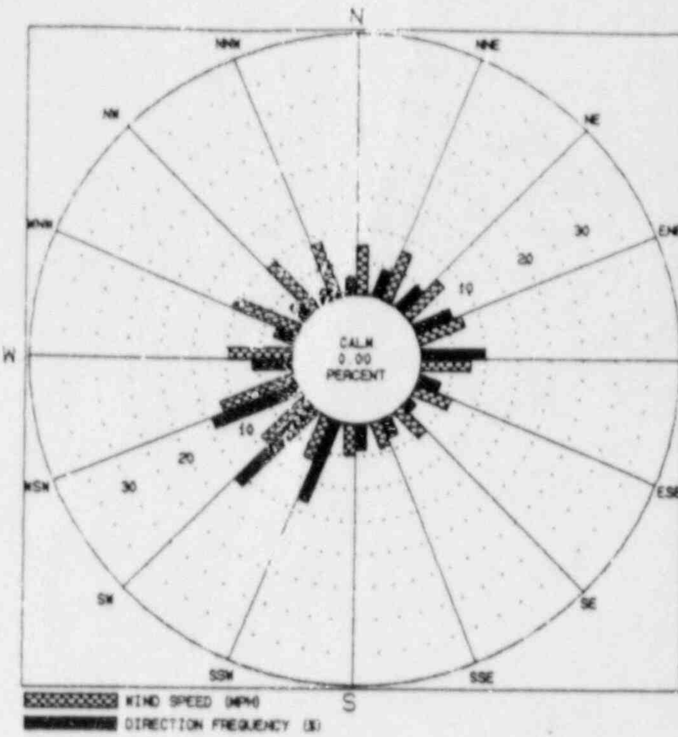

DAVIS BESSE
APRIL 1987
10M LEVEL

FIGURE 4-10 (continued)

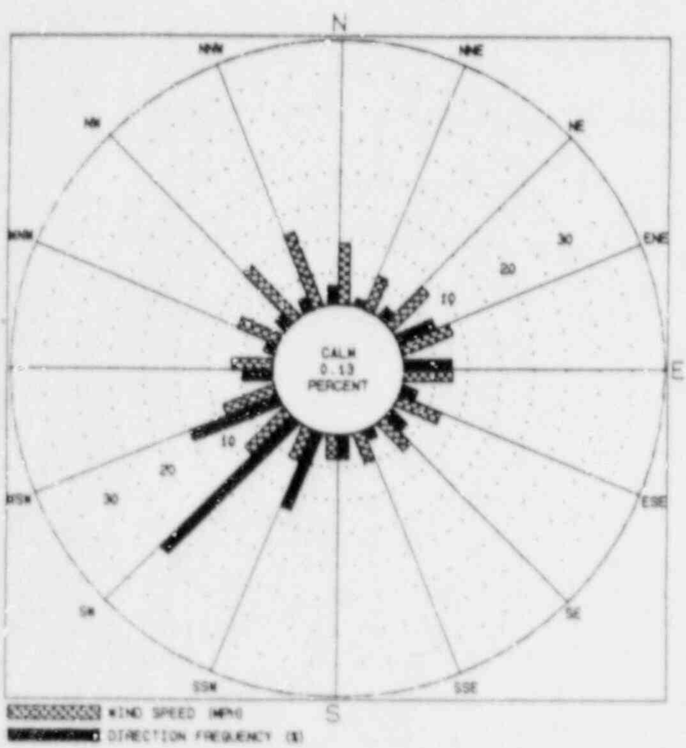
DAVIS-BESSE NUCLEAR POWER STATION
10m WIND ROSES JANUARY THROUGH DECEMBER 1987



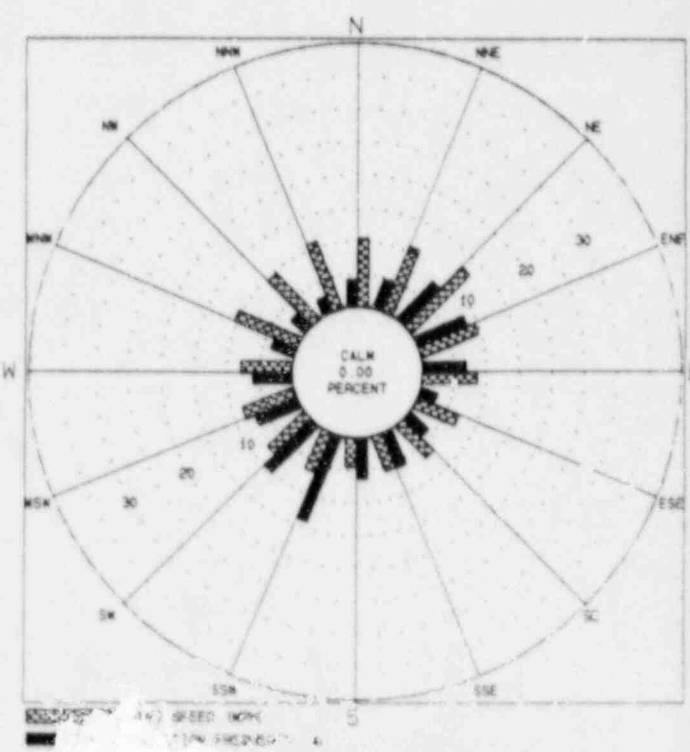

DAVIS BESSE
MAY 1987
10M LEVEL




DAVIS BESSE
JUNE 1987
10M LEVEL



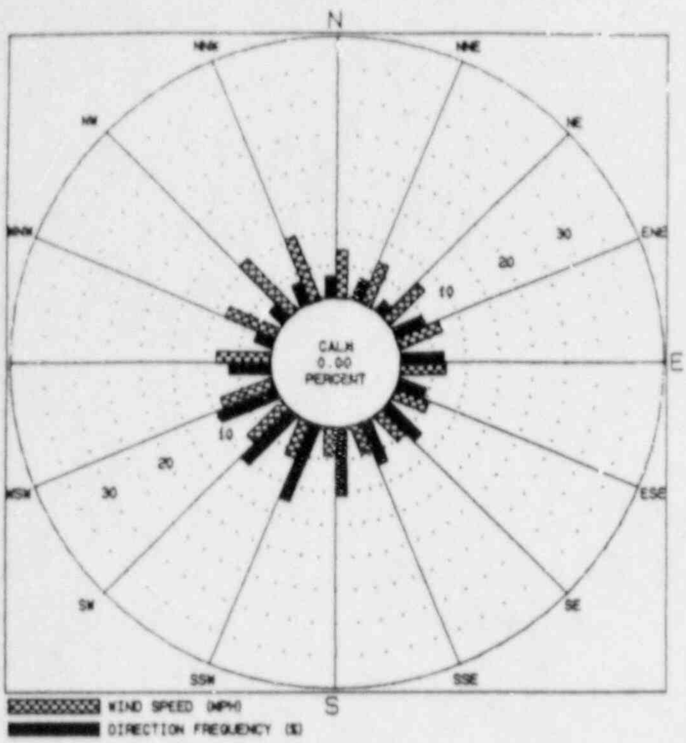

DAVIS BESSE
JULY 1987
10M LEVEL



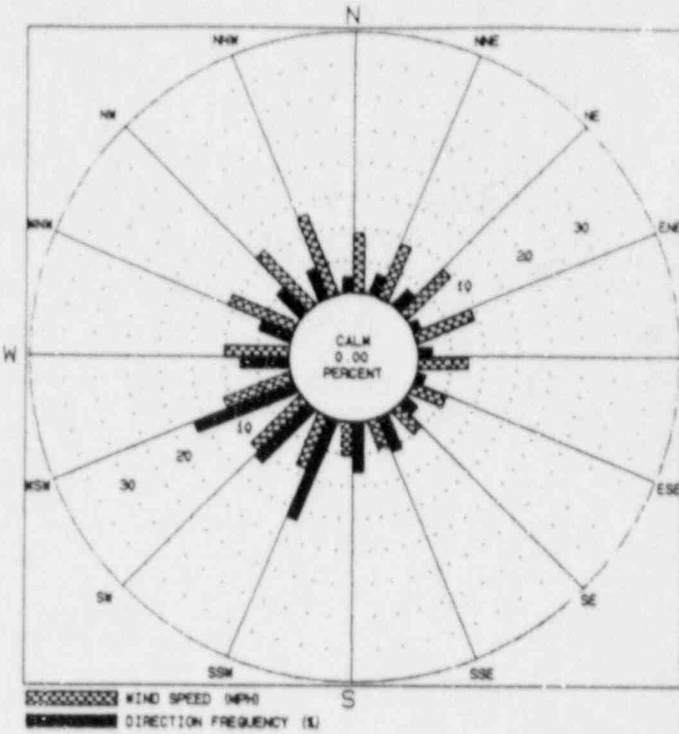

[illegible]AVI[illegible] BESSE
[illegible]ST [illegible]98[illegible]
[illegible] LEVEL

FIGURE 4-10 (continued)

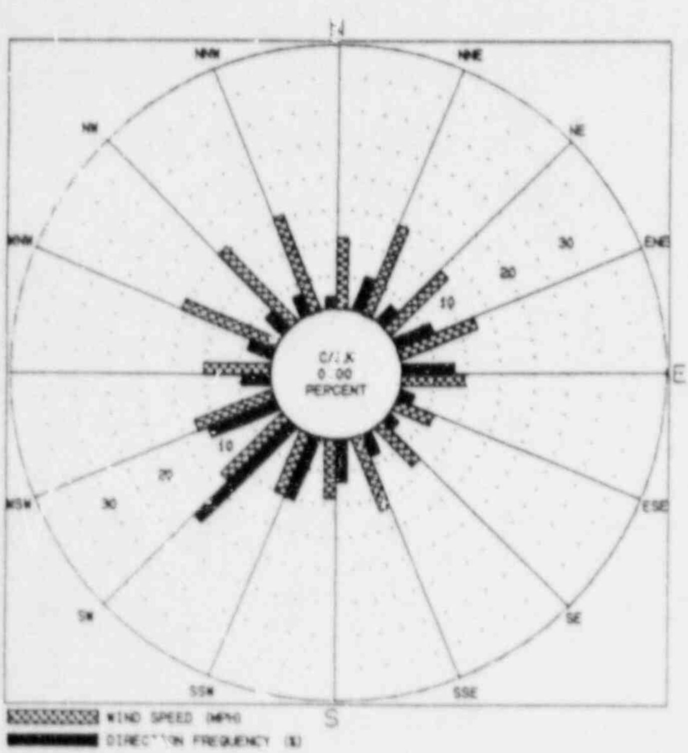
DAVIS-BESSE NUCLEAR POWER STATION
10m WIND ROSES JANUARY THROUGH DECEMBER 1987



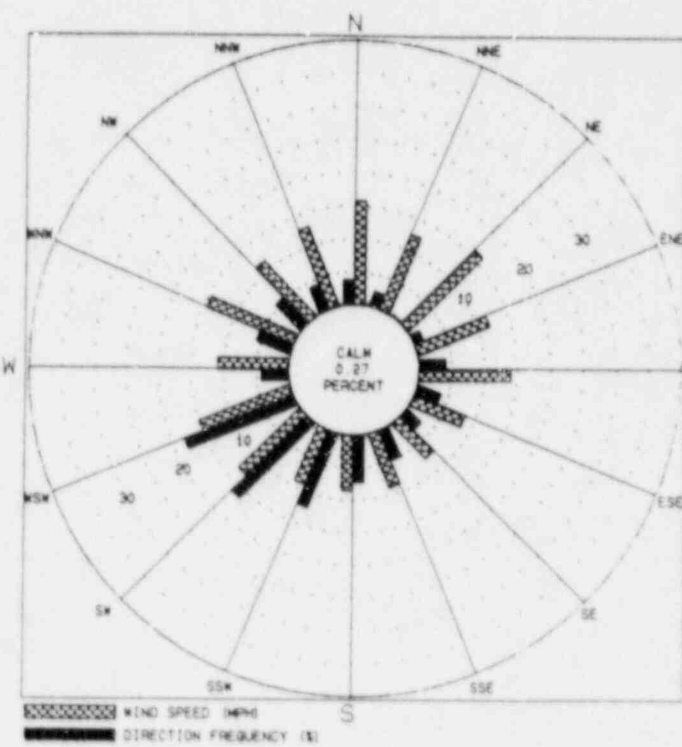

DAVIS BESSE
SEPTEMBER 1987
10M LEVEL




DAVIS BESSE
OCTOBER 1987
10M LEVEL



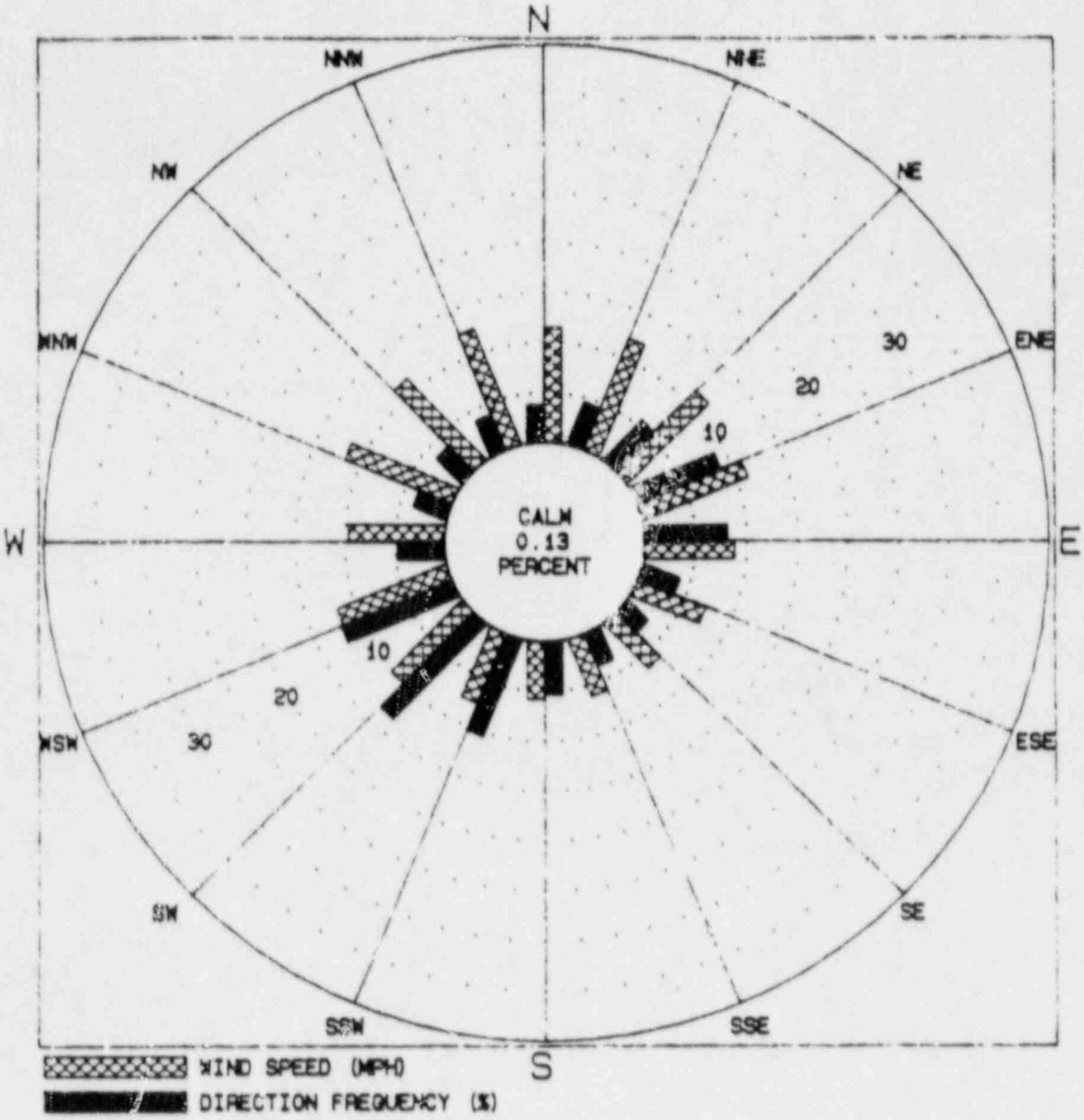

DAVIS BESSE
NOVEMBER 1987
10M LEVEL




DAVIS BESSE
DECEMBER 1987
10M LEVEL

FIGURE 4-10 (continued)

DAVIS-BESSE NUCLEAR POWER STATION
10m WIND ROSES JANUARY THROUGH DECEMBER 1987




DAVIS BESSE
ANNUAL 1987
10M LEVEL

## Table 4-1
## Summary of Meteorolgical Instrumentation used at Davis-Besse Nuclear Power Station

| Site | Parameter | Level (meters) | Instrument (A) | Threshold | Accuracy |
|---|---|---|---|---|---|
| Main and Aux | Wind Speed | 100 and 75 (main)<br>10 (aux) | Climet model 011-1, transmitter<br>Climet model 025-2, translator<br>(Esterline Angus Recorder, model E1102R) | 0.6 mph | ± 1% or 0.15 mph which ever is greater |
| Main and Aux | Wind Direction | 100 and 75 (main)<br>10 (aux) | Climet model 012-10, transmitter<br>Climet model 025-2, translator<br>(Esterline Angus Recorder, model E1102R) | 0.75 mph | ± 3.0° |
| Main | Temperature | 100, 75 and 10 | Teledyne Geotech Aspirated Thermal Radiation Shield, model 327 with Platinum RTB (T-200)<br>(Esterline Angus Multipoint Recorder, model E1124E) | n/a | ± 0.09°F |
| Main | Differential temperature | 100-10<br>75-10 | Teledyne Geotech Platinum RTB T/delta T processor, model 21.35<br>(Esterline Angus Multipoint Recorder model E1124E) | n/a | ± 0.18°F |
| Main | Dew Point Temperature | 100, 10 | Cambridge model 110S-M<br>(Esterline Angus Multipoint Recorder model E1124E) | n/a | ± 0.5°F |
| Aux | Precipitation | 1 | Belfort tipping Bucket Rain Gauge Cat. No. 5-405H<br>Teledyne Geotech Processor, model 21.52<br>(Esterline Angus Multipoint Recorder model E1124E) | n/a | ± 1% at 1 in/hr<br>± 4% at 3 in/hr<br>± 6% at 6 in/hr |

Main = 340 foot tower    Aux = 35 foot tower    (A) Recording equipment indicated in parenthesis

# Table 4-2
## Davis-Besse Nuclear Power Station Meteorological Data Recovery
## January 1, 1987 through December 31, 1987

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100m Wind Speed | 100.00 | 100.00 | 99.87 | 100.00 | 100.00 | 91.67 | 93.28 | 76.21 | 100.00 | 100.00 | 100.00 | 100.00 | 96.71 |
| 100m Wind Direction | 100.00 | 100.00 | 99.87 | 100.00 | 100.00 | 99.72 | 93.55 | 76.21 | 100.00 | 100.00 | 100.00 | 100.00 | 97.40 |
| 75m Wind Speed | 100.00 | 100.00 | 99.60 | 100.00 | 100.00 | 99.72 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 99.94 |
| 75m Wind Direction | 100.00 | 100.00 | 99.87 | 100.00 | 100.00 | 99.86 | 100.00 | 99.33 | 100.00 | 100.00 | 100.00 | 100.00 | 99.92 |
| 10m Wind Speed | 100.00 | 100.00 | 99.87 | 100.00 | 100.00 | 99.72 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 99.97 |
| 10m Wind Direction | 100.00 | 100.00 | 99.87 | 100.00 | 100.00 | 99.72 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 99.86 | [illegible] |
| 10m Ambient Temperature | 100.00 | 100.00 | 98.52 | 99.86 | 100.00 | 98.33 | 100.00 | 98.66 | 100.00 | 99.87 | 100.00 | 100.00 | [illegible] |
| 10m Dew Point Temperature | 98.92 | 88.24 | 99.73 | 100.00 | 100.00 | 99.86 | 100.00 | 97.85 | 100.00 | 100.00 | 100.00 | 100.00 | [illegible] |
| Delta T (100m - 10m) | 100.00 | 100.00 | 98.52 | 99.86 | 100.00 | 98.33 | 100.00 | 90.05 | 100.00 | 97.85 | 97.36 | 97.72 | [illegible] |
| Delta T (75m - 10m) | 100.00 | 100.00 | 98.52 | 99.86 | 100.00 | 98.33 | 100.00 | 97.04 | 100.00 | 97.85 | 97.50 | 99.33 | 99.03 |
| Precipitation | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Joint 100m winds and Delta T (100m - 10m) | 100.00 | 100.00 | 98.52 | 99.86 | 100.00 | 90.14 | 93.28 | 73.92 | 100.00 | 97.85 | 97.36 | 97.72 | 95.67 |
| Joint 75m winds and Delta T (100m-10m) | 100.00 | 100.00 | 98.39 | 99.86 | 100.00 | 98.06 | 100.00 | 90.05 | 100.00 | 97.85 | 97.36 | 97.72 | 98.25 |
| Joint 75m winds and Delta T (75m - 10m) | 100.00 | 100.00 | 98.39 | 99.86 | 100.00 | 98.06 | 100.00 | 96.37 | 100.00 | 97.85 | 97.50 | 99.33 | 98.94 |
| Joint 10m winds and Delta T (75m - 10m) | 100.00 | 100.00 | 98.52 | 99.86 | 100.00 | 98.06 | 100.00 | 97.04 | 100.00 | 97.85 | 97.50 | 99.19 | 99.00 |

## Table 4-3
## Summary of Meteorological Data Measured at Davis-Besse Nuclear Power Station For January 1, 1987 through December 31, 1987

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **100m WIND** | | | | | | | | | | | | | |
| Mean Speed (mph) | 17.2 | 18.2 | 18.3 | 18.3 | 14.9 | 14.5 | 13.7 | 15.1 | 13.2 | 16.5 | 20.6 | 19.3 | 16.7 |
| Max. Speed (mph) | 44.4 | 43.6 | 40.7 | 50.7 | 32.1 | 29.0 | 27.6 | 34.4 | 32.7 | 35.0 | 37.2 | 57.5 | 57.5 |
| Direction of Max. Speed | NE | NW | NNE | N | WNW | WSW | NNW | WNW | NNW | SSW | SSE | SW | SW |
| Date of Max. Speed | 19 | 8 | 8 | 4 | 14 | 7 | 14 | 2 | 30 | 2 | 17 | 15 | 15 Dec |
| **75m WIND** | | | | | | | | | | | | | |
| Mean Speed (mph) | 15.9 | 16.9 | 16.8 | 16.9 | 14.1 | 13.2 | 12.4 | 13.4 | 12.1 | 15.4 | 19.0 | 18.1 | 15.3 |
| Max. Speed (mph) | 41.7 | 42.8 | 36.8 | 47.7 | 30.0 | 27.7 | 26.7 | 30.0 | 31.9 | 31.8 | 34.5 | 49.0 | 49.0 |
| Direction of Max. Speed | ENE | NW | NNE | N | WSW | WSW | NNW | NW | NNW | SSW | SSE | SW | SW |
| Date of Max. Speed | 19 | 8 | 9 | 4 | 11 | 27 | 14 | 2 | 30 | 2 | 17 | 15 | 15 Dec |
| **10m WIND** | | | | | | | | | | | | | |
| Mean Speed (mph) | 11.0 | 11.0 | 11.5 | 11.7 | 9.3 | 8.4 | 7.7 | 8.5 | 6.9 | 9.3 | 12.1 | 12.1 | 10.0 |
| Max. Speed (mph) | 30.1 | 31.2 | 32.8 | 37.4 | 24.2 | 21.1 | 18.4 | 21.3 | 22.6 | 21.6 | 24.2 | 40.5 | 40.5 |
| Direction of Max. Speed | WSW | NNW | NNE | N | NNE | WSW | N | NE | NW | WSW | NNW | SW | SW |
| Date of Max. Speed | 11 | 8 | 9 | 4 | 12 | 28 | 14 | 4 | 30 | 17 | 20 | 15 | 15 Dec |
| **10m AMBIENT TEMPERATURE** | | | | | | | | | | | | | |
| Mean (F) | 27.3 | 29.7 | 38.3 | 48.5 | 63.3 | 71.6 | 75.7 | 71.7 | 64.9 | 48.1 | 44.8 | 34.6 | 51.6 |
| Max. (F) | 45.5 | 43.7 | 74.1 | 79.3 | 87.4 | 89.4 | 91.8 | 93.0 | 82.7 | 70.9 | 73.6 | 55.0 | 93.0 |
| Date of Max. | 6 | 22 | 29 | 21 | 29 | 14 | 20 | 2 | 27 | 16 | 3 | 9 | 2 Aug |
| Min (F) | -3.3 | 10.3 | 15.7 | 24.0 | 43.6 | 53.3 | 60.9 | 53.0 | 45.3 | 31.6 | 19.9 | 11.7 | -3.3 |
| Date of Min. | 24 | 15 | 10 | 1 | 1 | 5 | 14 | 29 | 26 | 22 | 21 | 30 | 24 Jan |

## Table 4-3
## Summary of Meteorological Data Measured at Davis-Besse Nuclear Power Station For January 1, 1987 through December 31, 1987
(Continued)

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10m DEW POINT TEMPERATURE** | | | | | | | | | | | | | |
| Mean (F) | 21.1 | 22.8 | 29.1 | 39.4 | 51.5 | 60.7 | 67.1 | 62.4 | 56.1 | 38.3 | 35.8 | 29.2 | 43.1 |
| Max. (F) | 42.6 | 36.5 | 50.5 | 56.7 | 72.1 | 73.0 | 77.4 | 75.6 | 68.8 | 52.6 | 57.7 | 52.1 | 77.4 |
| Date of Max. | 15 | 28 | 29 | 20 | 28 | 21 | 20 | 2 | 7 | 5 | 17 | 9 | 20 Jul |
| Min. (F) | -11.2 | -2.7 | 0.1 | 6.1 | 25.2 | 35.9 | 46.9 | 41.4 | 36.3 | 26.9 | -0.3 | 6.6 | -11.2 |
| Date of Min. | 24 | 15 | 10 | 1 | 1 | 10 | 27 | 24 | 25 | 3 | 21 | 30 | 24 Jan |
| **PRECIPITAITON** | | | | | | | | | | | | | |
| Total (inches) | 0.84 | 0.34 | 1.86 | 1.36 | 3.12 | 6.76 | 3.31 | 6.75 | 2.62 | 1.28 | 2.56 | 3.10 | 33.90 |
| Rain Days (a) | 9 | 2 | 8 | 10 | 8 | 15 | 9 | 10 | 14 | 14 | 12 | 14 | 125 |
| Max. in One Day | 0.22 | 0.33 | 0.88 | 0.30 | 1.00 | 2.87 | 1.27 | 1.21 | 0.71 | 0.27 | 1.27 | 1.09 | 2.87 |
| Date | 29 | 28 | 30 | 4 | 3 | 20 | 25 | 26 | 15 | 24 | 25 | 15 | 20 Jun |
| Max. in One Hour | 0.08 | 0.08 | 0.15 | 0.09 | 0.39 | 0.77 | 0.76 | 0.71 | 0.62 | 0.13 | 0.20 | 0.36 | 0.77 |
| Date | 29 | 28 | 30 | 4, 5 | 30 | 19 | 25 | 2 | 12 | 24 | 27 | 15 | 19 Jun |

(a) Rain days are defined as a day in which 0.01 inches of rain or frozen precipitation has fallen.

# Table 4-4
# Classification of Meteorological Data

## Wind Direction

| Wind Sector | Wind Direction (Degrees) | | |
|---|---|---|---|
| N | 348.75 | TO | 11.25 |
| NNE | 11.25 | TO | 33.75 |
| NE | 33.75 | TO | 56.25 |
| ENE | 56.25 | TO | 78.75 |
| E | 78.75 | TO | 101.25 |
| ESE | 101.25 | TO | 123.75 |
| SE | 123.75 | TO | 146.25 |
| SSE | 146.25 | TO | 168.75 |
| S | 168.75 | TO | 191.25 |
| SSW | 191.25 | TO | 213.75 |
| SW | 213.75 | TO | 236.25 |
| WSW | 236.25 | TO | 258.75 |
| W | 258.75 | TO | 281.25 |
| WNW | 281.25 | TO | 303.75 |
| NW | 303.75 | TO | 326.25 |
| NNW | 326.25 | TO | 348.75 |

## Pasquill Stability

| Stability Class | Delta T (100m - 10m) (340 ft - 35 ft) (°F) | Delta T (75m - 10m) (250 ft - 35 ft) (°F) |
|---|---|---|
| A (extremely unstable) | T < -3.18 | T < -2.24 |
| B (moderately unstable) | -3.18 < = T < -2.84 | -2.24 < = T < -2.01 |
| C (slightly unstable) | -2.84 < = T < -2.51 | -2.01 < = T < -1.77 |
| D (neutral) | -2.51 < = T < -0.84 | -1.77 < = T < -0.59 |
| E (slightly stable) | -0.84 < = T < 2.51 | -0.59 < = T < 1.77 |
| F (moderately stable) | 2.51 < = T < 6.69 | 1.77 < = T < 4.72 |
| G (extremely stable) | 6.69 < = T | 4.72 < = T |

## Table 4-5
## Monthly and Annual Stability Class Frequency Distributions Based On Delta T (100m - 10m) For January 1, 1987 Through December 31, 1987 (in percent)

| 100m-10m | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| JAN | 0.00 | 0.00 | 0.00 | 70.03 | 25.54 | 3.63 | 0.81 |
| FEB | 0.00 | 0.00 | 0.00 | 48.21 | 39.88 | 11.46 | 0.45 |
| MAR | 0.00 | 0.00 | 1.09 | 60.85 | 25.24 | 6.68 | 6.14 |
| APR | 0.00 | 0.56 | 1.81 | 50.21 | 30.74 | 11.96 | 4.73 |
| MAY | 0.00 | 0.81 | 3.23 | 58.87 | 23.25 | 11.16 | 2.69 |
| JUN | 0.56 | 2.54 | 6.07 | 54.10 | 25.85 | 10.31 | 0.56 |
| JUL | 7.80 | 7.93 | 9.14 | 34.01 | 28.63 | 11.69 | 0.81 |
| AUG | 0.60 | 3.43 | 10.45 | 44.03 | 25.07 | 15.07 | 1.34 |
| SEP | 0.28 | 0.14 | 1.11 | 46.39 | 37.08 | 9.44 | 5.56 |
| OCT | 0.00 | 0.27 | 1.24 | 54.81 | 25.69 | 13.32 | 4.67 |
| NOV | 0.00 | 0.00 | 0.43 | 51.07 | 37.09 | 8.84 | 2.57 |
| DEC | 0.00 | 0.00 | 0.28 | 73.45 | 21.32 | 4.95 | 0.00 |
| ANNUAL | 0.79 | 1.31 | 2.88 | 53.96 | 28.69 | 9.83 | 2.54 |

## Table 4-6
## Monthly and Annual Stability Class Frequency Distributions Based on Delta T (75m - 10m) For January 1, 1987 Through December 31, 1987 (in percent)

| 75m-10m | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| JAN | 0.00 | 0.00 | 1.61 | 68.15 | 25.54 | 3.49 | 1.21 |
| FEB | 0.00 | 0.00 | 3.72 | 46.58 | 40.33 | 8.18 | 1.19 |
| MAR | 0.14 | 0.41 | 3.96 | 60.57 | 21.69 | 6.82 | 6.41 |
| AFR | 0.28 | 1.53 | 4.59 | 51.74 | 26.56 | 9.60 | 5.70 |
| MAY | 0.94 | 2.15 | 3.63 | 59.41 | 20.83 | 9.27 | 3.76 |
| JUN | 4.10 | 4.24 | 8.90 | 46.33 | 26.27 | 9.60 | 0.56 |
| JUL | 17.34 | 6.45 | 6.59 | 28.23 | 29.97 | 10.48 | 0.94 |
| AUG | 4.43 | 7.89 | 8.73 | 39.75 | 25.62 | 11.91 | 1.66 |
| SEP | 0.00 | 0.28 | 3.47 | 44.03 | 37.36 | 9.72 | 5.14 |
| OCT | 0.27 | 0.96 | 2.47 | 53.57 | 24.18 | 14.56 | 3.98 |
| NOV | 0.00 | 0.00 | 1.14 | 50.71 | 36.89 | 7.83 | 3.42 |
| DEC | 0.00 | 0.00 | 0.14 | 73.88 | 21.11 | 4.74 | 0.14 |
| ANNUAL | 2.33 | 2.01 | 4.07 | 52.01 | 27.90 | 8.84 | 2.85 |

# Table 4-7
## Davis-Besse Nuclear Power Station
## Stability Classes by Hour of Day for 1987, Based on 100m-10m Delta T

**Stability Index**

| Hour of Day | A | B | C | D | E | F | G | TOTAL | FG | EFG |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 129 | 144 | 69 | 18 | 360 | 87 | 231 |
| 2 | 0 | 0 | 0 | 126 | 150 | 57 | 24 | 357 | 81 | 231 |
| 3 | 0 | 0 | 0 | 133 | 137 | 69 | 22 | 361 | 91 | 228 |
| 4 | 0 | 0 | 0 | 137 | 137 | 69 | 18 | 361 | 87 | 224 |
| 5 | 0 | 0 | 0 | 133 | 145 | 64 | 17 | 359 | 81 | 226 |
| 6 | 0 | 0 | 0 | 150 | 131 | 58 | 19 | 358 | 77 | 208 |
| 7 | 0 | 0 | 0 | 158 | 135 | 50 | 14 | 357 | 64 | 199 |
| 8 | 0 | 0 | 0 | 203 | 114 | 29 | 9 | 355 | 38 | 152 |
| 9 | 1 | 1 | 11 | 247 | 81 | 11 | 3 | 355 | 14 | 95 |
| 10 | 6 | 8 | 28 | 267 | 42 | 5 | 0 | 356 | 5 | 47 |
| 11 | 8 | 17 | 28 | 276 | 23 | 5 | 1 | 358 | 6 | 29 |
| 12 | 12 | 17 | 36 | 268 | 18 | 4 | 2 | 357 | 6 | 24 |
| 13 | 15 | 19 | 36 | 266 | 15 | 4 | 2 | 357 | 6 | 21 |
| 14 | 12 | 19 | 33 | 260 | 26 | 5 | 2 | 357 | 7 | 33 |
| 15 | 7 | 16 | 31 | 270 | 26 | 5 | 3 | 358 | 8 | 34 |
| 16 | 4 | 12 | 21 | 273 | 39 | 6 | 4 | 359 | 10 | 49 |
| 17 | 2 | 4 | 17 | 257 | 70 | 6 | 3 | 359 | 9 | 79 |
| 18 | 1 | 0 | 3 | 234 | 107 | 9 | 4 | 358 | 13 | 120 |
| 19 | 0 | 0 | 0 | 186 | 141 | 26 | 4 | 357 | 30 | 171 |
| 20 | 0 | 0 | 0 | 138 | 178 | 41 | 6 | 363 | 47 | 225 |
| 21 | 0 | 0 | 1 | 130 | 172 | 52 | 7 | 362 | 59 | 231 |
| 22 | 0 | 0 | 3 | 135 | 155 | 59 | 11 | 363 | 70 | 225 |
| 23 | 0 | 0 | 0 | 140 | 139 | 73 | 10 | 362 | 83 | 222 |
| 24 | 0 | 0 | 0 | 130 | 145 | 70 | 16 | 361 | 86 | 231 |
| TOTAL | 68 | 113 | 248 | 4646 | 2470 | 846 | 219 | 8610 | 1065 | 3535 |
| PERCENT | 0.79 | 1.31 | 2.88 | 53.96 | 28.69 | 9.83 | 2.54 | 100.00 | 12.37 | 41.06 |

# Table 4-8
## Davis-Besse Nuclear Power Station
## Stability Classes by Hour of Day for 1987, Based on 75m-10m Delta T

### Stability Index

| Hour of Day | A | B | C | D | E | F | G | TOTAL | FG | EFG |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0 | 0 | 2 | 127 | 150 | 64 | 20 | 363 | 84 | 234 |
| 2 | 0 | 0 | 0 | 131 | 151 | 55 | 24 | 361 | 79 | 230 |
| 3 | 0 | 0 | 0 | 136 | 149 | 55 | 23 | 363 | 78 | 227 |
| 4 | 0 | 0 | 1 | 138 | 146 | 62 | 16 | 363 | 78 | 224 |
| 5 | 0 | 0 | 0 | 140 | 152 | 55 | 16 | 363 | 71 | 223 |
| 6 | 0 | 0 | 0 | 151 | 151 | 43 | 18 | 363 | 61 | 212 |
| 7 | 0 | 0 | 0 | 168 | 138 | 40 | 16 | 362 | 56 | 194 |
| 8 | 0 | 1 | 4 | 220 | 101 | 26 | 7 | 359 | 33 | 134 |
| 9 | 2 | 6 | 22 | 249 | 69 | 8 | 3 | 359 | 11 | 80 |
| 10 | 19 | 15 | 29 | 255 | 37 | 4 | 0 | 359 | 4 | 41 |
| 11 | 27 | 21 | 35 | 256 | 17 | 2 | 2 | 360 | 4 | 21 |
| 12 | 32 | 26 | 40 | 245 | 13 | 2 | 2 | 360 | 4 | 17 |
| 13 | 39 | 19 | 53 | 231 | 13 | 4 | 2 | 361 | 6 | 19 |
| 14 | 35 | 22 | 43 | 233 | 24 | 0 | 3 | 360 | 3 | 27 |
| 15 | 26 | 23 | 46 | 235 | 24 | 2 | 4 | 360 | 6 | 30 |
| 16 | 15 | 22 | 38 | 242 | 35 | 3 | 6 | 361 | 9 | 44 |
| 17 | 6 | 16 | 20 | 249 | 61 | 5 | 4 | 361 | 9 | 70 |
| 18 | 1 | 3 | 11 | 221 | 108 | 11 | 5 | 360 | 16 | 124 |
| 19 | 0 | 0 | 1 | 190 | 133 | 29 | 6 | 359 | 35 | 168 |
| 20 | 0 | 0 | 1 | 141 | 172 | 40 | 10 | 364 | 50 | 222 |
| 21 | 0 | 0 | 1 | 134 | 160 | 57 | 11 | 363 | 68 | 228 |
| 22 | 0 | 0 | 1 | 142 | 145 | 61 | 15 | 364 | 76 | 221 |
| 23 | 0 | 0 | 3 | 141 | 137 | 66 | 17 | 364 | 83 | 220 |
| 24 | 0 | 0 | 2 | 137 | 134 | 73 | 17 | 363 | 90 | 224 |
| TOTAL | 202 | 174 | 353 | 4512 | 2420 | 767 | 247 | 8675 | 1014 | 3434 |
| PERCENT | 2.33 | 2.01 | 4.07 | 52.01 | 27.90 | 8.84 | 2.85 | 100.00 | 11.69 | 39.59 |

## Table 4-9
## Davis-Besse Nuclear Power Station
## Stability Class Persistence Periods for 1987, Based on 100m-10m Delta T

| Duration In Hours | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 1 | 9 | 29 | 76 | 88 | 149 | 78 | 21 |
| 2 | 7 | 16 | 33 | 49 | 117 | 50 | 10 |
| 3 | 1 | 12 | 15 | 37 | 72 | 29 | 4 |
| 4 | 0 | 4 | 8 | 50 | 59 | 23 | 6 |
| 5 | 3 | 0 | 3 | 32 | 36 | 22 | 2 |
| 6 | 1 | 0 | 1 | 26 | 31 | 15 | 3 |
| 7-11 | 3 | 0 | 1 | 132 | 71 | 31 | 7 |
| 12-23 | 0 | 0 | 0 | 54 | 37 | 2 | 4 |
| 24-47 | 0 | 0 | 0 | 33 | 3 | 0 | 0 |
| 48-71 | 0 | 0 | 0 | 5 | 0 | 0 | 0 |
| 72-95 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 96-120 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| 120 + | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Longest Case | 7 | 4 | 8 | 103 | 28 | 13 | 13 |

## Table 4-10
## Davis-Besse Nuclear Power Station
## Stability Class Persistence Periods for 1987, Based on 75m-10m Delta T

| Duration In Hours | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| 1 | 20 | 72 | 137 | 100 | 167 | 96 | 20 |
| 2 | 11 | 27 | 51 | 80 | 121 | 50 | 14 |
| 3 | 12 | 12 | 20 | 70 | 74 | 35 | 8 |
| 4 | 8 | 3 | 4 | 57 | 50 | 26 | 3 |
| 5 | 1 | 0 | 5 | 35 | 39 | 18 | 4 |
| 6 | 3 | 0 | 1 | 24 | 32 | 11 | 7 |
| 7-11 | 9 | 0 | 1 | 115 | 76 | 21 | 7 |
| 12-23 | 0 | 0 | 0 | 64 | 29 | 3 | 3 |
| 24-47 | 0 | 0 | 0 | 29 | 3 | 0 | 0 |
| 48-71 | 0 | 0 | 0 | 4 | 0 | 0 | 0 |
| 72-95 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 96-120 | 0 | 0 | 0 | 2 | 0 | 0 | 0 |
| 120 + | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Longest Case | 7 | 4 | 7 | 115 | 39 | 12 | 13 |

## Table 4-11
## Local Climatological Data Comparisons for Toledo, Cleveland, and Davis-Besse Nuclear Power Station for 1987

| | TEMPERATURE | | | | | | PRECIPITATION | | |
|---|---|---|---|---|---|---|---|---|---|
| | MAX. | MIN. | RANGE | AVG. MAX. | AVG. MIN. | AVG. RANGE | TOTAL | DAYS | AVG. WS. |
| **JANUARY** | | | | | | | | | |
| TOLEDO | 50 | -7 | 57 | 32.3 | 19.3 | 13.0 | 1.87 | 12 | 10.1 |
| DAVIS-BESSE | 45.5 | -3.3 | 48.8 | 31.5 | 22.9 | 8.6 | 0.84 | 9 | 11.0 |
| CLEVELAND | 52 | -2 | 52 | 33.7 | 21.1 | 12.6 | 1.98 | 16 | 9.7 |
| **FEBRUARY** | | | | | | | | | |
| TOLEDO | 50 | 7 | 43 | 38.5 | 21.5 | 17.0 | 0.53 | 2 | 10.5 |
| DAVIS-BESSE | 43.7 | 10.3 | 33.4 | 34.2 | 25.4 | 8.8 | 0.34 | 2 | 11.0 |
| CLEVELAND | 52 | 6 | 46 | 38.6 | 22.4 | 16.2 | 0.49 | 3 | 9.1 |
| **MARCH** | | | | | | | | | |
| TOLEDO | 76 | 14 | 62 | 50.1 | 29.3 | 20.8 | 1.78 | 9 | 10.9 |
| DAVIS-BESSE | 74.1 | 15.7 | 58.4 | 44.5 | 33.0 | 11.5 | 1.86 | 8 | 11.5 |
| CLEVELAND | 76 | 14 | 62 | 48.9 | 29.1 | 19.8 | 3.84 | 9 | 10.2 |
| **APRIL** | | | | | | | | | |
| TOLEDO | 87 | 19 | 68 | 61.5 | 39.1 | 22.4 | 1.72 | 11 | 10.9 |
| DAVIS-BESSE | 79.3 | 24.0 | 55.3 | 54.5 | 43.0 | 11.5 | 1.36 | 10 | 11.7 |
| CLEVELAND | 82 | 15 | 67 | 58.3 | 39.9 | 18.4 | 2.97 | 14 | 10.3 |
| **MAY** | | | | | | | | | |
| TOLEDO | 92 | 35 | 57 | 75.4 | 49.6 | 25.8 | 2.32 | 11 | 8.1 |
| DAVIS-BESSE | 87.4 | 43.6 | 43.8 | 70.9 | 56.1 | 14.8 | 3.12 | 8 | 9.3 |
| CLEVELAND | 91 | 36 | 55 | 74.2 | 51.7 | 22.5 | 2.40 | 13 | 8.5 |
| **JUNE** | | | | | | | | | |
| TOLEDO | 93 | 41 | 52 | 83.2 | 58.4 | 24.8 | 5.62 | 12 | 8.7 |
| DAVIS-BESSE | 89.4 | 53.3 | 36.1 | 77.9 | 65.0 | 12.9 | 6.76 | 15 | 8.4 |
| CLEVELAND | 90 | 42 | 48 | 80.2 | 60.1 | 20.1 | 7.94 | 12 | 8.5 |

## Table 4-11
## Local Climatological Data Comparisons for Toledo, Cleveland, and Davis-Besse Nuclear Power Station for 1987
### (continued)

| | TEMPERATURE | | | | | | PRECIPITATION | | |
|---|---|---|---|---|---|---|---|---|---|
| | MAX. | MIN. | RANGE | AVG. MAX. | AVG. MIN. | AVG. RANGE | TOTAL | DAYS | AVG. WS. |
| **JULY** | | | | | | | | | |
| TOLEDO | 96 | 48 | 48 | 85.7 | 64.1 | 21.6 | 1.51 | 11 | 7.8 |
| DAVIS-BESSE | 91.8 | 60.9 | 30.9 | 82.4 | 69.2 | 13.2 | 3.31 | 9 | 7.7 |
| CLEVELAND | 94 | 52 | 42 | 84.5 | 65.8 | 18.7 | 3.36 | 7 | 7.9 |
| **AUGUST** | | | | | | | | | |
| TOLEDO | 98 | 42 | 56 | 82.5 | 59.4 | 23.1 | 4.45 | 9 | 8.4 |
| DAVIS-BESSE | 93.0 | 53.0 | 40.0 | 77.7 | 65.1 | 12.6 | 6.75 | 10 | 8.5 |
| CLEVELAND | 94 | 50 | 44 | 79.5 | 62.0 | 17.5 | 5.51 | 11 | 8.2 |
| **SEPTEMBER** | | | | | | | | | |
| TOLEDO | 87 | 37 | 50 | 75.6 | 52.0 | 23.6 | 2.31 | 13 | 6.8 |
| DAVIS-BESSE | 82.7 | 45.3 | 37.4 | 71.4 | 58.6 | 12.8 | 2.62 | 14 | 6.9 |
| CLEVELAND | 82 | 41 | 41 | 72.8 | 54.2 | 18.6 | 2.07 | 11 | 6.7 |
| **OCTOBER** | | | | | | | | | |
| TOLEDO | 72 | 22 | 50 | 56.9 | 33.8 | 23.1 | 2.2[illegible] | 12 | 9.1 |
| DAVIS-BESSE | 70.9 | 31.6 | 39.3 | 54.9 | 41.2 | 13.7 | 1.28 | 14 | 9.3 |
| CLEVELAND | 71 | 27 | 44 | 57.1 | 37.9 | 19.2 | 3.41 | 14 | 8.3 |
| **NOVEMBER** | | | | | | | | | |
| TOLEDO | 78 | 15 | 63 | 53.2 | 35.6 | 17.5 | 2.59 | 13 | 11.4 |
| DAVIS-BESSE | 73.6 | 19.9 | 53.7 | 51.4 | 38.8 | 12.6 | 2.56 | 12 | 12.1 |
| CLEVELAND | 77 | 19 | 58 | 53.8 | 38.4 | 15.4 | 1.02 | 10 | 11.3 |
| **DECEMBER** | | | | | | | | | |
| TOLEDO | 54 | 2 | 52 | 39.2 | 26.7 | 12.5 | 3.80 | 18 | 10.9 |
| DAVIS-BESSE | 55.0 | 11.7 | 43.3 | 38.9 | 30.3 | 8.6 | 3.10 | 14 | 12.1 |
| CLEVELAND | 58 | 10 | 48 | 40.2 | 29.3 | 10.9 | 2.96 | 18 | 11.5 |
| **ANNUAL** | | | | | | | | | |
| TOLEDO | 98 | -7 | 105 | 61.3 | 40.8 | 20.5 | 30.71 | 133 | 9.5 |
| DAVIS-BESSE | 93.0 | -3.3 | 96.3 | 57.6 | 45.8 | 11.8 | 33.90 | 125 | 10.0 |
| CLEVELAND | 94 | -2 | 96 | 60.3 | 42.8 | 17.5 | 37.95 | 133 | 9.2 |

## Table 4-1
## Summary of Meteorolgical Instrumentation used at Davis-Besse Nuclear Power Station

| Site | Parameter | Level (meters) | Instrument (A) | Threshold | Accuracy |
|---|---|---|---|---|---|
| Main and Aux | Wind Speed | 100 and 75 (main)<br>10 (aux) | Climet model 011-1, transmitter<br>Climet model 025-2, translator<br>(Esterline Angus Recorder,<br>model E1102R) | 0.6 mph | ± 1% or 0.15 mph which ever is greater |
| Main and Aux | Wind Direction | 100 and 75 (main)<br>10 (aux) | Climet model 012-10, transmitter<br>Climet model 025-2, translator<br>(Esterline Angus Recorder,<br>model E1102R) | 0.75 mph | ± 3.0° |
| Main | Temperature | 100, 75 and 10 | Teledyne Geotech Aspirated<br>Thermal Radiation Shield, model<br>327 with Platinum RTB (T-200)<br>(Esterline Angus Multipoint Recorder,<br>model E1124E) | n/a | ± 0.09°F |
| Main | Differential temperature | 100-10<br>75-10 | Teledyne Geotech Platinum RTB T/<br>delta T processor, model 21.35<br>(Esterline Angus Multipoint<br>Recorder model E1124E) | n/a | ± 0.18°F |
| Main | Dew Point Temperature | 100, 10 | Cambridge model 110S-M<br>(Esterline Angus Multipoint<br>Recorder model E1124E) | n/a | ± 0.5°F |
| Aux | Precipitation | 1 | Belfort tipping Bucket Rain Gauge<br>Cat. No. 5-405H<br>Teledyne Geotech Processor,<br>model 21.52<br>(Esterline Angus Multipoint<br>Recorder model E1124E) | n/a | ± 1% at 1 in/hr<br>± 4% at 3 in/hr<br>± 6% at 6 in/hr |

Main = 340 foot tower  Aux = 35 foot tower  (A) Recording equipment indicated in parenthesis

## Table 4-2
## Davis-Besse Nuclear Power Station Meteorological Data Recovery
## January 1, 1987 through December 31, 1987

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 100m Wind Speed | 100.00 | 100.00 | 99.87 | 100.00 | 100.00 | 91.67 | 93.28 | 76.21 | 100.00 | 100.00 | 100.00 | 100.00 | 96.71 |
| 100m Wind Direction | 100.00 | 100.00 | 99.87 | 100.00 | 100.00 | 99.72 | 93.55 | 76.21 | 100.00 | 100.00 | 100.00 | 100.00 | 97.40 |
| 75m Wind Speed | 100.00 | 100.00 | 99.60 | 100.00 | 100.00 | 99.72 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 99.94 |
| 75m Wind Direction | 100.00 | 100.00 | 99.87 | 100.00 | 100.00 | 99.86 | 100.00 | 99.33 | 100.00 | 100.00 | 100.00 | 100.00 | 99.92 |
| 10m Wind Speed | 100.00 | 100.00 | 99.87 | 100.00 | 100.00 | 99.72 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 99.97 |
| 10m Wind Direction | 100.00 | 100.00 | 99.87 | 100.00 | 100.00 | 99.72 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 99.86 | 99.95 |
| 10m Ambient Temperature | 100.00 | 100.00 | 98.52 | 99.86 | 100.00 | 98.33 | 100.00 | 98.66 | 100.00 | 99.87 | 100.00 | 100.00 | 99.60 |
| 10m Dew Point Temperature | 98.92 | 88.24 | 99.73 | 100.00 | 100.00 | 99.86 | 100.00 | 97.85 | 100.00 | 100.00 | 100.00 | 100.00 | 99.79 |
| Delta T (100m - 10m) | 100.00 | 100.00 | 98.52 | 99.86 | 100.00 | 98.33 | 100.00 | 90.05 | 100.00 | 97.85 | 97.36 | 97.72 | 98.29 |
| Delta T (75m - 10m) | 100.00 | 100.00 | 98.52 | 99.86 | 100.00 | 98.33 | 100.00 | 97.04 | 100.00 | 97.85 | 97.50 | 99.33 | 99.03 |
| Precipitation | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 |
| Joint 100m winds and Delta T (100m - 10m) | 100.00 | 100.00 | 98.52 | 99.86 | 100.00 | 90.14 | 93.28 | 73.92 | 100.00 | 97.85 | 97.36 | 97.72 | 95.67 |
| Joint 75m winds and Delta T (100m-10m) | 100.00 | 100.00 | 98.39 | 99.86 | 100.00 | 98.06 | 100.00 | 90.05 | 100.00 | 97.85 | 97.36 | 97.72 | 98.25 |
| Joint 75m winds and Delta T (75m - 10m) | 100.00 | 100.00 | 98.39 | 99.86 | 100.00 | 98.06 | 100.00 | 96.37 | 100.00 | 97.85 | 97.50 | 99.33 | 98.94 |
| Joint 10m winds and Delta T (75m - 10m) | 100.00 | 100.00 | 98.52 | 99.86 | 100.00 | 98.06 | 100.00 | 97.04 | 100.00 | 97.85 | 97.50 | 99.19 | 99.00 |

## Table 4-3
## Summary of Meteorological Data Measured at Davis-Besse Nuclear Power Station
## For January 1, 1987 through December 31, 1987

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **100m WIND** | | | | | | | | | | | | | |
| Mean Speed (mph) | 17.2 | 18.2 | 18.3 | 18.3 | 14.9 | 14.5 | 13.7 | 15.1 | 13.2 | 16.5 | 20.6 | 19.3 | 16.7 |
| Max. Speed (mph) | 44.4 | 43.6 | 40.7 | 50.7 | 32.1 | 29.0 | 27.6 | 34.4 | 32.7 | 35.0 | 37.2 | 57.5 | 57.5 |
| Direction of Max. Speed | NE | NW | NNE | N | WNW | WSW | NNW | WNW | NNW | SSW | SSE | SW | SW |
| Date of Max. Speed | 19 | 8 | 8 | 4 | 14 | 7 | 14 | 2 | 30 | 2 | 17 | 15 | 15 Dec |
| **75m WIND** | | | | | | | | | | | | | |
| Mean Speed (mph) | 15.9 | 16.9 | 16.8 | 16.9 | 14.1 | 13.2 | 12.4 | 13.4 | 12.1 | 15.4 | 19.0 | 18.1 | 15.3 |
| Max. Speed (mph) | 41.7 | 42.8 | 36.8 | 47.7 | 30.0 | 27.7 | 26.7 | 30.0 | 31.9 | 31.8 | 34.5 | 49.0 | 49.0 |
| Direction of Max. Speed | ENE | NW | NNE | N | WSW | WSW | NNW | NW | NNW | SSW | SSE | SW | SW |
| Date of Max. Speed | 19 | 8 | 9 | 4 | 11 | 27 | 14 | 2 | 30 | 2 | 17 | 15 | 15 Dec |
| **10m WIND** | | | | | | | | | | | | | |
| Mean Speed (mph) | 11.0 | 11.0 | 11.5 | 11.7 | 9.3 | 8.4 | 7.7 | 8.5 | 6.9 | 9.3 | 12.1 | 12.1 | 10.0 |
| Max. Speed (mph) | 30.1 | 31.2 | 32.8 | 37.4 | 24.2 | 21.1 | 18.4 | 21.3 | 22.6 | 21.6 | 24.2 | 40.5 | 40.5 |
| Direction of Max. Speed | WSW | NNW | NNE | N | NNE | WSW | N | NE | NW | WSW | NNW | SW | SW |
| Date of Max. Speed | 11 | 8 | 9 | 4 | 12 | 28 | 14 | 4 | 30 | 17 | 20 | 15 | 15 Dec |
| **10m AMBIENT TEMPERATURE** | | | | | | | | | | | | | |
| Mean (F) | 27.3 | 29.7 | 38.3 | 48.5 | 63.3 | 71.6 | 75.7 | 71.7 | 64.9 | 48.1 | 44.8 | 34.6 | 51.6 |
| Max. (F) | 45.5 | 43.7 | 74.1 | 79.3 | 87.4 | 89.4 | 91.8 | 93.0 | 82.7 | 70.9 | 73.6 | 55.0 | 93.0 |
| Date of Max. | 6 | 22 | 29 | 21 | 29 | 14 | 20 | 2 | 27 | 16 | 3 | 9 | 2 Aug |
| Min (F) | -3.3 | 10.3 | 15.7 | 24.0 | 43.6 | 53.3 | 60.9 | 53.0 | 45.3 | 31.6 | 19.9 | 11.7 | -3.3 |
| Date of Min. | 24 | 15 | 10 | 1 | 1 | 5 | 14 | 29 | 26 | 22 | 21 | 30 | 24 Jan |

# Table 4-3
## Summary of Meteorological Data Measured at Davis-Besse Nuclear Power Station For January 1, 1987 through December 31, 1987
(Continued)

| | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **10m DEW POINT TEMPERATURE** | | | | | | | | | | | | | |
| Mean (F) | 21.1 | 22.8 | 29.1 | 39.4 | 51.5 | 60.7 | 67.1 | 62.4 | 56.1 | 38.3 | 35.8 | 29.2 | 43.1 |
| Max. (F) | 42.6 | 36.5 | 50.5 | 56.7 | 72.1 | 73.0 | 77.4 | 75.6 | 68.8 | 52.6 | 57.7 | 52.1 | 77.4 |
| Date of Max. | 15 | 28 | 29 | 20 | 28 | 21 | 20 | 2 | 7 | 5 | 17 | 9 | 20 Jul |
| Min. (F) | -11.2 | -2.7 | 0.1 | 6.1 | 25.2 | 35.9 | 46.9 | 41.4 | 36.3 | 26.9 | -0.3 | 6.6 | -11.2 |
| Date of Min. | 24 | 15 | 10 | 1 | 1 | 10 | 27 | 24 | 25 | 3 | 21 | 30 | 24 Jan |
| **PRECIPITAITON** | | | | | | | | | | | | | |
| Total (inches) | 0.84 | 0.34 | 1.86 | 1.36 | 3.12 | 6.76 | 3.31 | 6.75 | 2.62 | 1.28 | 2.56 | 3.10 | 33.90 |
| Rain Days (a) | 9 | 2 | 8 | 10 | 8 | 15 | 9 | 10 | 14 | 14 | 12 | 14 | 125 |
| Max. in One Day | 0.22 | 0.33 | 0.88 | 0.30 | 1.00 | 2.87 | 1.27 | 1.21 | 0.71 | 0.27 | 1.27 | 1.09 | 2.87 |
| Date | 29 | 28 | 30 | 4 | 3 | 20 | 25 | 26 | 15 | 24 | 25 | 15 | 20 Jun |
| Max. in One Hour | 0.08 | 0.08 | 0.15 | 0.09 | [illegible] | 0.77 | 0.76 | 0.71 | 0.62 | 0.13 | 0.20 | 0.36 | 0.77 |
| Date | 29 | 28 | 30 | 4, 5 | 30 | 19 | 25 | 2 | 12 | 24 | 27 | 15 | 19 Jun |

(a) Rain days are defined as a day in which 0.01 inches of rain or frozen precipitation has fallen.

PHOTO: COURTESY OF USFWS

# IMPACT ASSESSMENTS

# ENVIRONMENTAL IMPACT ASSESSMENT

Environmental Impact Assessments (EIA) provide the means by which the integrity of the Davis-Besse Nuclear Power Station and its surrounding ecosystems can be maintained and enhanced. Basic requirements for studies of this kind are found in the Final Environmental Impact Statement (FEIS) for the site. Whenever a change is proposed to a design, procedure, or process, the effects of the change should be evaluated and an environmental impact assessment prepared as necessary.

An EIA is instituted following the request by a group or department at the station. Most often, EIA's deal with construction projects or with the introduction of new facilities such as parking lots.

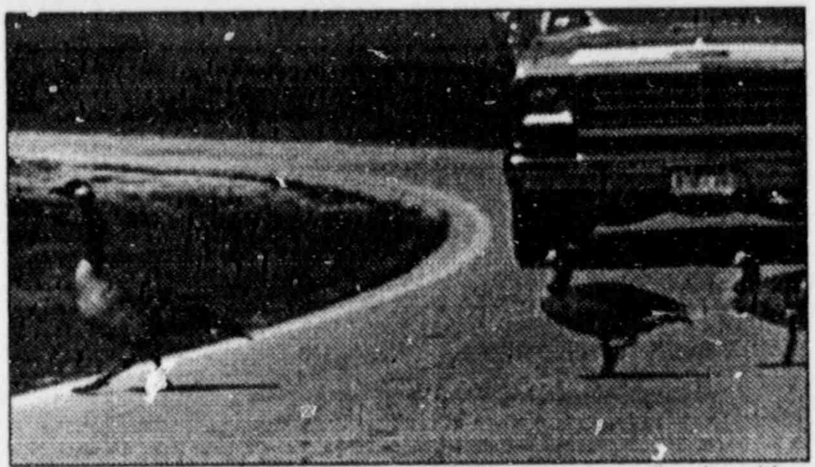


Fig. 5-1: Davis-Besse protects the wildlife they share the site with through the Environmental Impact Assessment Program. Even before a new parking lot is installed, the Environmental Compliance Dept. carefully researches the possible effects on the wildlife to ensure that none of the local populations are harmed

The first step in preparing an EIA is to determine the scope of the project. Sometimes, projects are small and will not involve any environmental disturbance. These projects do not receive a full EIA. Larger projects do require more in depth studies.

The environmental consequences of the proposal are identified next. These are determined by looking at different areas which might be impacted such as air quality, water quality, noise, and wildlife habitat. Most often projects will have some impact on these areas. The individual preparing the EIA must evaluate all available information to determine whether or not the benefits provided by the proposed project will off-set this impact.

The EIA also illustrates possible alternatives to the proposed project. These are provided to ensure that many different ways of satisfying the project are evaluated prior to its implementation. This often saves money and additional environmental impact in the future.

The results of the comparisons of the alternatives are then summarized and the proposal is evaluated based on its cost versus its benefits. A proposal should yield more benefits than the cost it takes to implement it. If this condition does not exist, serious thought should be given to not beginning such a project.

Following completion of all the steps mentioned above, the individual or group preparing the EIA will make recommendations based upon what was found. These recommendations can either support the proposal or deter from it, but they must always reflect the findings of the EIA to ensure that both the station and its surrounding environment are protected.

Among the EIA's performed during 1987 were the construction of the Administration Building Annex, the construction of a Flammable Materials Storage Building, and the proposed construction of a Fire Brigade Training Tower. These projects are summarized on the following pages.

### Construction of the Administration Building Annex

To provide additional office, storage, and laboratory space for various departments, some of which are presently housed in trailers, the Station Space Allocation Committee proposed that an Annex be added to the Administration Building. This annex would provide for 26,000 square feet of space and would house approximately 170 individuals.

The Environmental Compliance Department evaluated the proposal and found no significant adverse impact from the project.

### Construction of a Flammable Materials Storage Building

At the present time, many flammables are stored alongside of other materials; system parts, supplies, and components, in the Station Warehouse. An Environmental Impact Assessment for the construction of a Flammable Materials Storage Building was prepared.

The 5,000 square foot building will be situated in the east laydown area, and surrounded by diking on all sides. A fire protection system is planned for the structure.

No significant impact for the structure was determined, however, due to its proximity to the Navarre Marsh it was recommended that the design address the control of liquids from spills and runoff in and around the building.

### Installation of a Fire Brigade Training Tower

The proposal to construct a training tower on the Davis-Besse site was evaluated. Construction of this "burn-building" would allow for much needed training in the area of structure fires.

Fig. 5-2: Because of Davis-Besse's commitment to protecting and preserving wildlife and the environment through practices such as Environmental Impact Assessments, animals such as this bald eagle have been sighted at the plant.

The tower portion of the building will be 39 feet high, with the ground floor of the building covering approximately 1,000 square feet.

During training activities, waste by-products would be generated from the various extinguishing techniques. Environmental Compliance recommended that adequate diking surround the training area and a collection system be installed and pumped-out when necessary.

It was determined that the project would have no significant environmental impact if precautions recommended were taken.

PHOTO: CAROLYN BURKEPILE

# MARSH MANAGEMENT

# MARSH MANAGEMENT

## Navarre Marsh

The Navarre Marsh is approximately 733 acres of low-lying land that exists as wetland habitat; located on the southwestern shore of Lake Erie where the Toussaint River and Lake Erie meet. Toledo Edison and the Cleveland Electric Illuminating Company co-own the marsh which they lease to the Fish and Wildlife Service, U.S. Department of Interior, whose personnel manage it as a part of the Ottawa National Wildlife Refuge. The maintaining of selected water levels, and the maintenance and repair of the access roads is managed by Toledo Edison. Toledo Edison is responsible for the inspection of the Marsh, and the monthly status reporting. These findings are then compared to the expected activity levels for each seasonal period and an evaluation of the marsh's progress is made. Also, careful observation is made to identify undesirable species such as purple loosestrife.

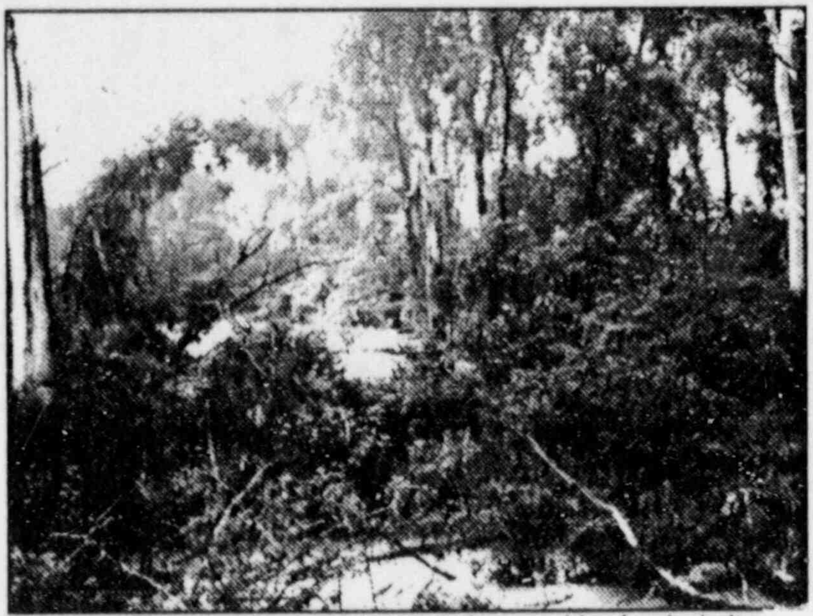


Fig. 6-1: The abundant marsh vegetation provides food, shelter, and a breeding ground for a vast array of wildlife.

The Navarre Marsh is completely enclosed by dikes protecting it from the flooding and wave action of Lake Erie. Besides protection from natural forces, the

Fig. 6-2: A Davis-Besse personnel inspects the marsh twice weekly.

dikes aid in controlling the water levels to obtain desired vegetation. During the spring, water is removed from the marsh; this is called a drawdown. The water level is important because it stimulates new growth or controls existing vegetation. This is the most important management tool for the Navarre Marsh and its use is determined based on the physical and biological characteristics of the marsh. Spring drawdown produces vegetation favorable to the nesting and feeding of waterfowl.

The Navarre Marsh vegetation will be discussed according to the type of area it is found in. Most of the vegetation is in the fresh water marsh. The plants in this area are divided into emergents, submergents, and floating varieties which

Fig. 6-3: During the marsh inspection, everything from water levels to the number and type of birds present is recorded.

Fig. 6-4: Future marsh inhabitants are warmed by the sun.

are found on the water's surface. Emergents are found growing in wet soil or out of the water. Plants such as cattails, softstem bulrush, arrowhead, white water lotus, smartweed, Walter's millet, rice-cut grass, biden and blue joint grass make up the majority of emergent plants. Submergents which grow under water are water-milfoil, coontail, bladderwort, curly-leaf pond weed and sago pond weeds. Duckweed (greater and lesser) and water meal are present on the water's surface. These plants provide food, cover and nesting areas for such animals as waterfowl, rails, great blue herons, great egrets, and muskrats. Another important area is the swamp, characterized by woody plants. Here soil is poorly drained or water stands during part of the growing season. The typical plants are button bush, hackberry, box elder, honey locust, red ash, silver maple, and hawthorn. The understory of the swamp consists of poison ivy, swamp loosestrife, sumac daylily, false solomon seal, and touch-me-not. This swamp is special because the button bush swamp is rare along the Lake Erie coast. Meeks and Hoffman estimated that 90% of the black-crowned night herons in Navarre Marsh use this area for feeding and resting (Bird Populations Common to the Sister Islands, the Role of Navarre Marsh, 1979). Green heron were also observed nesting in the area.

A narrow, dry beach ridge exists along the lake front where the Toussaint River and Lake Erie meet. Limited numbers of woody plants inhabit this area, but the most common are cottonwood, dogwood, willows, and sumacs. Various grasses, burdock, and a few understory plants grow here. This area has many dead trees standing which makes it valuable to raptors such as bald eagles, because it provides them with perches used during the hunting of prey.

Even the man-made dikes provide a habitat to many animals and plants. The dikes are covered with plants such as white and yellow sweet clover, wild grapes, nodding smartweed, golden rod, and several types of trees. These plants offer food and refuge to deer, rabbits, raccoons, muskrats, and many song birds.

A wide variety of animals do utilize the marsh. The best known resident of Navarre Marsh is the Canada goose, which can be seen throughout the marsh and plant site. The Canada goose and other waterfowl find plenty of food, shelter, and resting area which makes it ideal for them. Besides natural nesting sites, Navarre Marsh also has several artificial nesting areas, such as wood duck boxes, and goose tubs. Another aspect appealing to waterfowl is that

Fig. 6-5: A startled white-tail stands motionless.

Fig. 6-6: A resourceful hunter, the great Horned Owl feeds on a wide variety of prey.

Navarre Marsh is totally protected from hunting because it is a national wildlife refuge. This offers them a feeding and resting place during migration.

Besides waterfowl, raptors frequent the marsh. Owl, hawks, and eagles have been observed numerous times in the dead trees that border the marsh. The trees have also been used by a pair of great horned owls who produced three fledglings in 1987.

Many species of birds visit Navarre Marsh besides waterfowl and raptors. In the spring and fall warblers, vireos and kinglets stop here during their migrations north and south. Great blue heron and great egrets use the marsh as a feeding and resting area during the breeding season. Meeks and Hoffman estimated that as high as 10% of the breeding population of herons and egrets on West Sister Island use Navarre Marsh in the spring and summer. (Bird populations Common to the Sister Islands, the Role of Navarre Marsh, 1979). Gulls, rails, killdeer, and a wide variety of song birds can be observed throughout the year.

Several mammals use the marsh throughout the year, the most noticeable is the muskrat. The marsh is dotted with muskrat houses which serve as homes for the muskrat and nesting places for waterfowl. The muskrat population is kept in balance by trappers who are overseen by Ottawa National Wildlife Refuge personnel. Other furbearing animals seen here are raccoon, red fox, and mink.

Fig. 6-7: A prothonotary warbler rests on its migration north.

The largest mammal present at Navarre Marsh is the white-tail deer. Smaller mammals seen in the marsh are rabbits, voles, and squirrels.

Fig. 6-8: The 'engineer' of the Navarre marsh, the muskrat, builds highly visible houses from the ample supply of reeds.

Davis-Besse Nuclear Power Station is committed to protecting the wildlife in the marsh and has gone to great lengths to preserve it. This can be seen in the extensive dike system that was built to protect the area from flooding, and leaving the dead trees which aid in raptor feeding. The preservation of the button bush swamp, a rare wetland habitat, will be a goal of the personnel working in Navarre Marsh. This will be a primary concern which will continue well into the future.

## 1987 SUMMARY

Activity levels in pools Number 1 and 2 remained high throughout the spring, summer, and fall of 1987, with exceptional numbers of surface feeding ducks, coot, and wading birds being observed.

Plans in 1987 were to drain the two cattail marshes to expose the fertile bottom and encourage growth of new vegetation to fill the voids resulting from high water. Unfortunately, levels were not reduced as quickly as desired, and many areas remained without the new vegetation. The pools will once again be "drawn-down" in 1988, only much earlier, to facilitate rapid and widespread growth.

The third pool of the Navarre Marsh, recreated by the completion of the Toussaint River Dike, was successfully drained in July and August, 1987, marking its return as a vital wetlands area. Complications from the late seasonal drainage, such as a significant loss of forage fish, were experienced, but did not impact the development of the pool. At present, half of the 188 acre parcel remains without vegetation, however, its relatively dry condition will provide for quick germination in the spring.

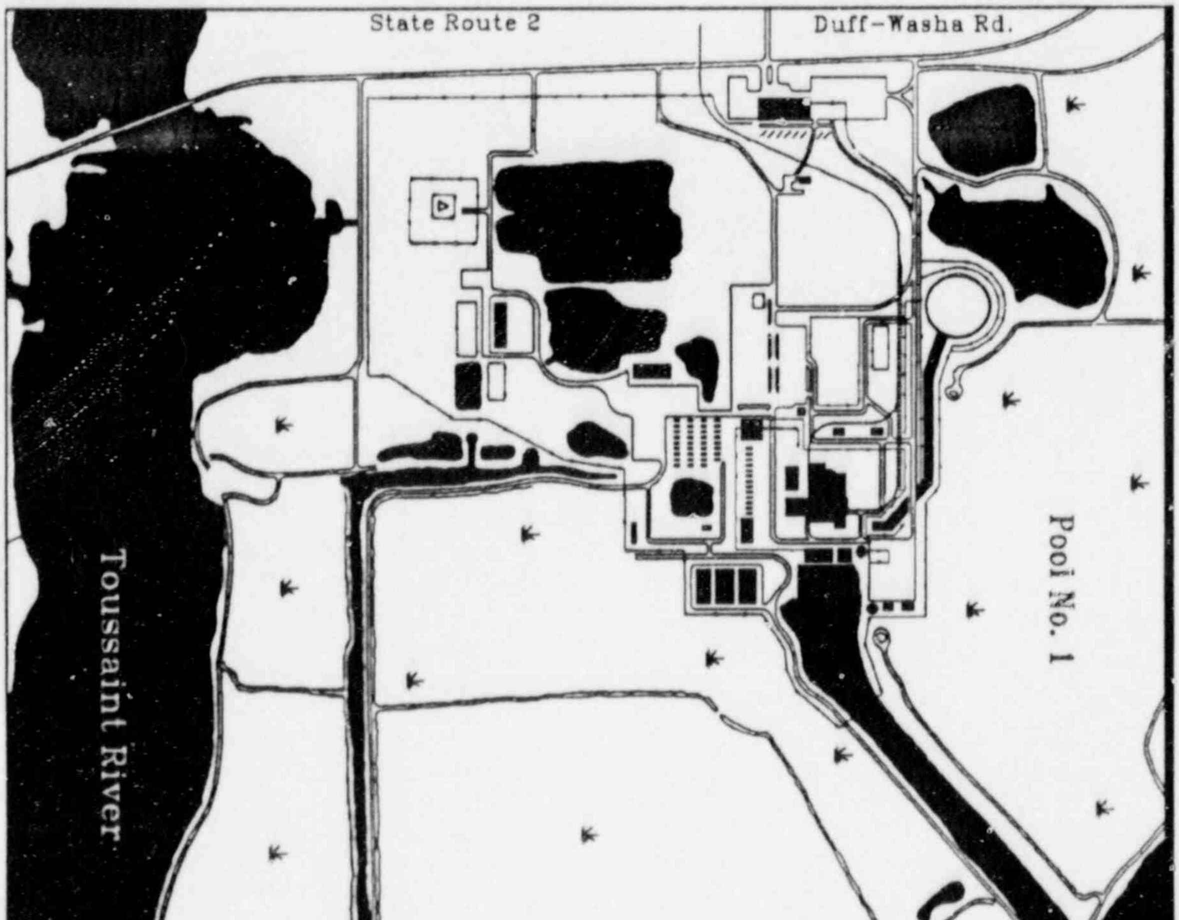



Fig. 6-9: Map of Davis-Besse Nuclear Power Station.

Construction of the lakefront revetment to protect the barrier beach formations and rare button bush swamp began in December, 1987, following acquisition of the Department of the Army permit. Work has progressed, and with the lower lake levels, project completion could be as soon as the first week of March, 1988. A full description of the project will be provided in the 1988 Operating Report.

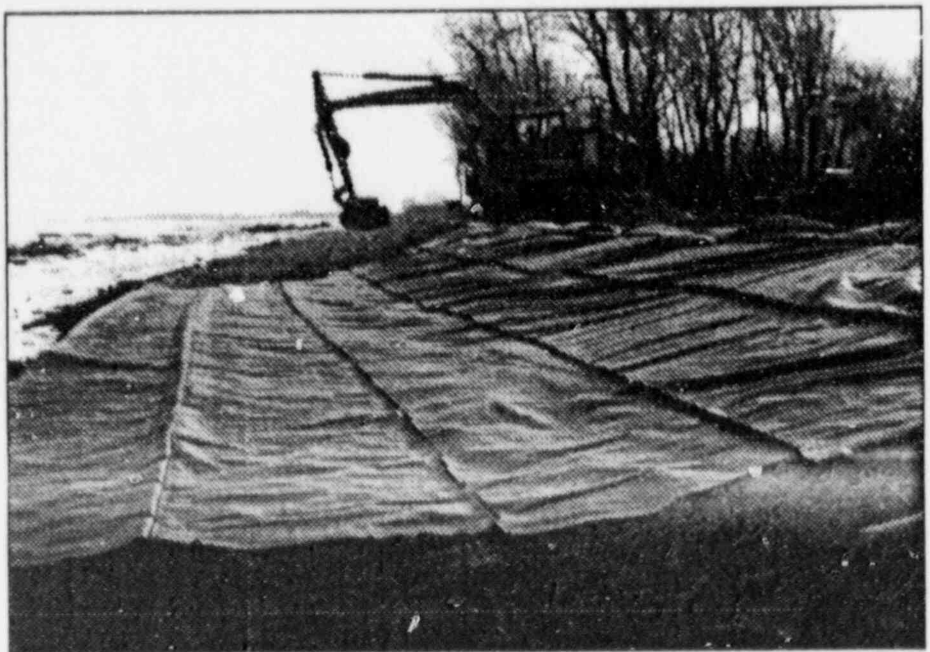


Fig. 6-10: Filter fabric is laid prior to stone to prevent loss of integrity to the revetment from wave action.

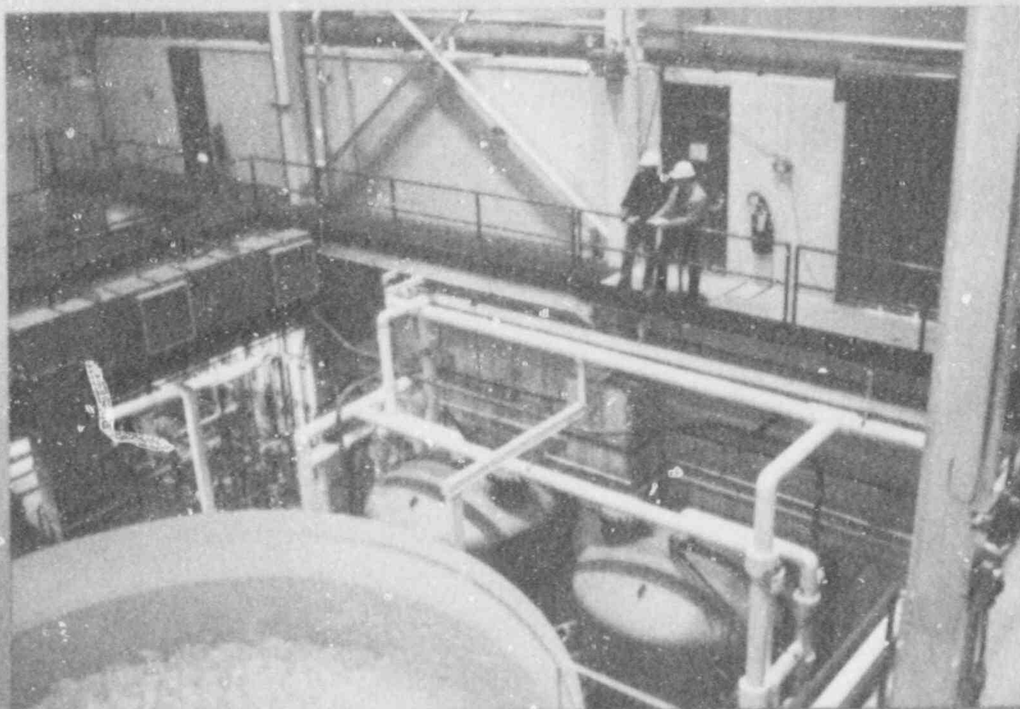


PHOTO: E. DELICATE

# WATER TREATMENT

# WATER TREATMENT

## Water Treatment Plant Operation

### Description

The Davis-Besse Nuclear Power Station uses Lake Erie as a water source for their water treatment facility. This water is treated with chlorine, lime, sodium aluminate, and a coagulant aide to make the water clean and safe for consumption. This water may also be further treated by a demineralization process. The demineralized water is used by many of the plant processes, including the turbine.

Fig 7-1: Clarified water is inspected prior to entering filters.

Operation of the water treatment plant falls under the purview of the Ohio Environmental Protection Agency (OEPA) and the Ohio Department of Health. The operation of the facility is reviewed by Class III Operators. Water supply activities at the water treatment plant are done in compliance with the Safe Drinking Water Act, and the regulations for public water supply as set forth by the OEPA.

Monthly operational reports, required by the Ohio EPA, are completed by Toledo Edison personnel and submitted to the agency. These are the "Drinking Water Operation Report" (OEPA form 5002) and "Drinking Water Contaminant Reports" (OEPA form 5001). These reports are submitted at the same time, contain analysis results, and sample dates. These data are compared to standards established by the OEPA. Operation of the facility is maintained by the Chemistry Department and monitored by the Environmental Compliance Department through daily inspections. Operational data are also reviewed for compliance and to recognize possible trends, such as a rise in chemical usage with regards to the seasons. A good example of this would be increasing the chlorine dosage when the weather becomes warmer. This enables us to treat the algae levels which, in turn, would impact clarity of the finished water. The health and safety of the plant operators and other site personnel are ensured through weekly housekeeping inspections.

Resulting sludge from the treatment process is discharged to the Number 1 settling basin for clarification prior to any discharge to the lake.

### Prechlorination System

All incoming raw water is first chlorinated. This serves two purposes. First, it destroys most undesirable micro-organisms and secondly, it oxidizes (burns up) some of the organics. This system enables the facility to operate more efficiently.

A temporary liquid sodium hypochlorite delivery system is presently used for prechlorination. This system has provided a more reliable means of prechlorination than the previous gas delivery system.

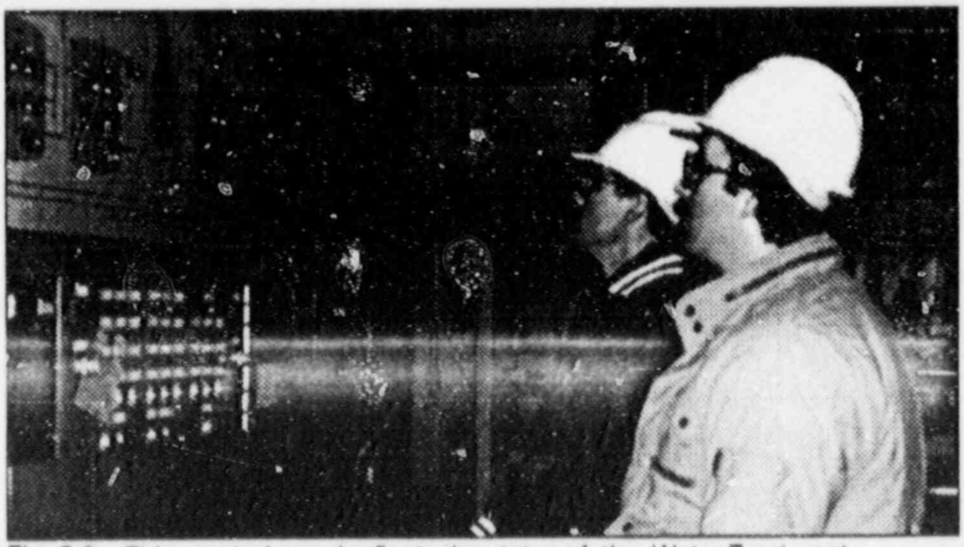


Fig. 7-2: This control panel reflects the status of the Water Treatment Plant Systems, most of which are fully automated.

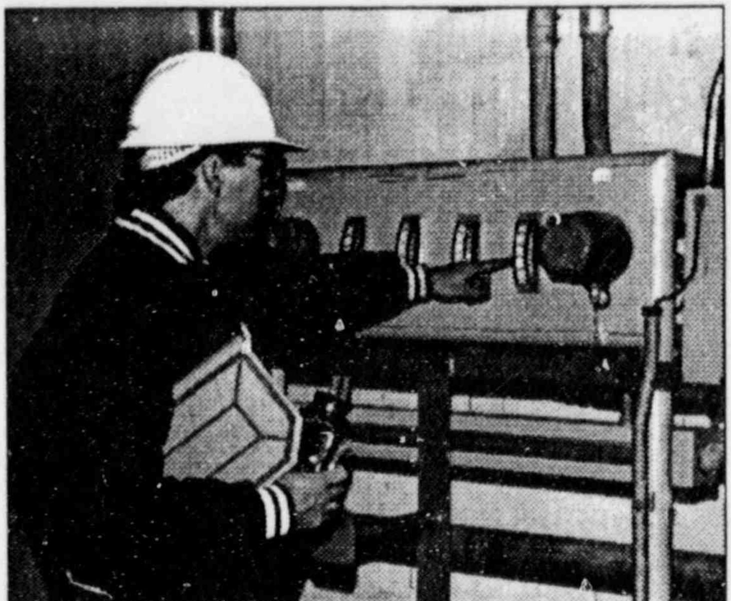


Fig. 7-3: Davis-Besse personnel regularly inspect controls at the Water Treatment Facility.

The clearwell storage tank is where treated water is held prior to domestic use or demineralization. The tank is filled and water is drawn from here as it is needed. This enables us to have a constant delivery of water to the system.

The interior of the clearwell storage tank was resurfaced in May, 1987. The new finish vastly improved tank appearance, however, schedules were impacted when special curing methods were employed due to manufacturer's recommendations. Domestic water service was continued throughout by use of the clearwell by-pass system.

A domestic water outage took place in November, 1987. This was to allow for repair of valves in the distribution system. Bottled water was provided along with portable toilets. Water was out-of-service for less than a day, however, OEPA did not approve the water for consumption until 2 days later.

## Wastewater (Sewage) Treatment Plant Operation

### Description

The wastewater treatment plant operation is supervised by an Ohio Certified Class III Wastewater Operator.

Wastewater generated by site personnel is treated at an onsite extended aeration package treatment facility designed for a flow of 38,000 gallons per day (GPD). This facility consists of two units, one a 15,000 GPD plant (WWTP Number 1); and the second being a 23,000 GPD plant (WWTP Number 2, see Figure 7-4). In the treatment process, wastewater from the various lift stations enters the facility at the equalization chamber. This structure is simply a chamber which

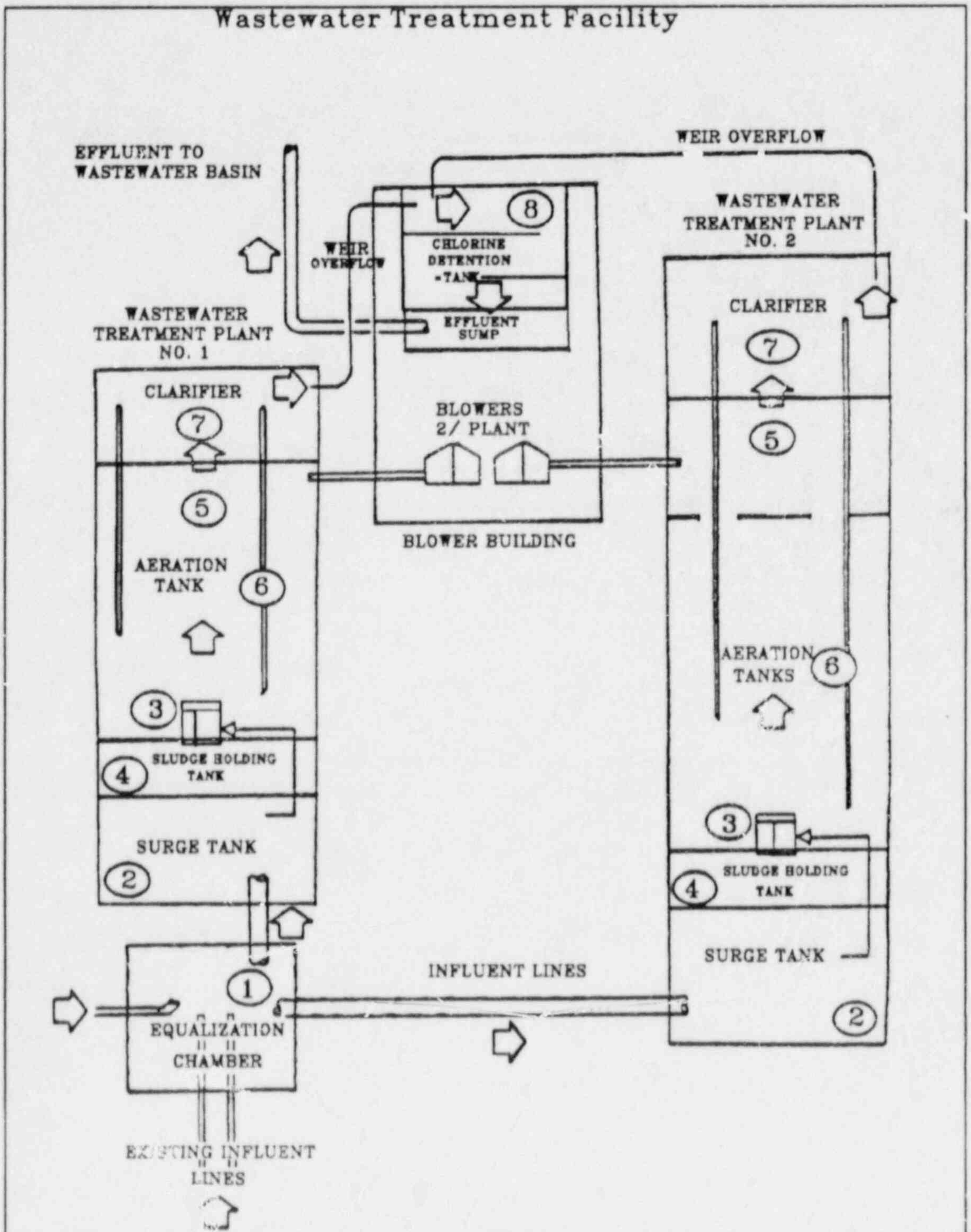



Fig. 7-4: A diagram of the Wastewater Treatment Plant.

collects raw wastewater and distributes it to the surge tanks of the treatment plants (Figure 7-4;1).

The wastewater enters the aeration tanks by pumps. Here, organics are digested by microorganisms. This is done in the presence of air supplied by blowers (Figure 7-4;5). This mixture of organics, microorganisms, and decomposed wastes is called activated sludge. The treated wastewater settles in a clarifier, and the clear effluent passes over a weir, leaving the plant by an effluent trough (Figure 7-4;7). The activated sludge contains the organisms necessary for continued treatment, and is pumped back to the front of the plant to digest the incoming wastewater (Figure 7-4;6). The effluent leaving the plant is disinfected with chlorine and is pumped to the wastewater treatment basin (NPDES Outfall 601) where further reduction in solids content and biochemical oxygen demand takes place (Figure 7-4;8).

In the beginning of the year, a building was constructed over Wastewater Treatment Plant Number 2. Lighting, heating, and ventilation systems were added to this plant. This is scheduled to be completed in March 1988.

The wastewater treatment plant laboratory was designed by Environmental Compliance in the fourth quarter of 1987. The majority of supplies arrived in 1987, with the remainder to arrive and be installed in 1988. Floor plans for the benches were drafted and sent out for bid. LISTA International received the contract and installed the laboratory in February 1988. This laboratory will allow Toledo Edison to develop a more comprehensive treatment program.

## National Pollutant Discharge and Elimination System (NPDES) Reporting

The Ohio Environmental Protection Agency (OEPA) has established limits on the amount of pollutants that Davis-Besse may discharge to the environment by waters of the state. These limits are regulated through the station's National Pollutant Discharge Elimination System (NPDES) permit number 2IB00011*DD. Parameters such as chlorine, suspended solids, and pH are monitored.

Toledo Edison prepares and submits the Monthly Ohio EPA NPDES Wastewater Reports. These reports are compiled, typed, reviewed, comments incorporated, approved, and submitted so as to be received by the OEPA by the fifteenth day of the month.

## Table 7-1
## National Pollutant Discharge and Elimination System (NPDES) Monitoring

### Davis-Besse Nuclear Power Station NPDES Outfalls

| Designation | Description |
|---|---|
| 001 | COLLECTION BOX: At point representative of discharge to Lake Erie. SOURCE OF WASTES: Low volume wastes (Outfalls 601 and 602), circulation system blowdown and occasional service water. (Sample collected at Davis-Besse Beach Sampling Station) |
| 002 | AREA RUNOFF: Discharge to Toussaint River. SOURCE OF WASTES: Storm water runoff, condensate pit sumps, turbine building drains, boiler drains, circulating pump house sumps. (Sample collected at discharge of Training Center Pond) |
| 003 | SCREENWASH CATCH BASIN: Outfall to Navarre Marsh SOURCE OF WASTES: Wash debris from water intake screens. (Sample collected at overflow of screenwash basin) |
| 601 | SEWAGE TREATMENT TERTIARY TREATMENT BASIN: Discharge from wastewater treatment system. SOURCE OF WASTES: Wastewater Treatment Facility. |
| 602 | LOW VOLUME WASTES: Discharge of settling basins. SOURCE OF WASTES: Water treatment residues, condensate polishing resins. (Sample collected at overflow Number 2 basin) |
| 801 | INTAKE TEMPERATURE: Intake water prior to cooling operation. (Values obtained from computer point at east end of forebay) |

Davis-Besse has six sampling points described in the NPDES permit. Five of these locations are discharge points, and one is a temperature monitoring location. Descriptions of these are provided in Table 7-1.

# 1987 NPDES Summary

## Outfall 001

The established limits for station effluent were not exceeded in 1987. The loss of power at the beach station occurred several times due to maintenance on transformers. A hand pump was supplied by Environmental Compliance to facilitate sampling.

## Outfall 002

During October, 1987 an exceedance of oil and grease limitations was recorded at the Training Center Pond discharge. The source of the oil was traced to the Station's Oil Interceptor Number 2, which required maintenance.

## Outfall 003

The screenwash catch basin overflow requires a single total suspended solids analysis each month and has no set limitations. The discharge screen to this basin remained clear and no overflow was experienced, as had occurred twice in 1986.

## Outfall 601

Due to increased flow to the Wastewater Treatment Facility, organic loadings on the Wastewater Basin rose proportionately, promoting the growth of algae in the basin. Microscopic evaluations indicated less significant occurrences of algae than in 1986. No violations of the Total Suspended Solids limitation were recorded in 1987. Algicide treatments were performed when necessary.

## Outfall 602

Slight problems were observed due to malfunctioning pump activation devices. The problem was corrected and no permit violations were experienced at this location.

## Outfall 801

The intake temperature is obtained from a computer point and is monitored continuously. No abnormal temperature variations were observed between intake and discharge temperature. An average differentiation of 4.4° Fahrenheit was recorded for the year.

## Cooling Tower Inspections

In May, a cooling tower basin inspection was performed. This inspection was to increase technical awareness of the system as well as to look for potential environmental problems.

Upon entering the basin, large amounts of debris were noted. The debris were identified as a carbonate scale. This type of scale is deposited onto the baffle system of the tower from the cooling water. The scale is then pushed from the baffles in sheets by the water pressure. This type of scale is natural and presented no environmental concern.

Secondly, an investigation of sludge deposits for signs of *Corbicula fluminea* (Asiatic clam) was conducted. This type of clam may cause serious difficulties with cooling systems. No signs of *Corbicula* were noted.


PHOTO: E. DELICATE

# ENVIRONMENTAL SAFETY

# ENVIRONMENTAL SAFETY

## Hazardous Chemical Waste Management System (Non-Radiological)

The chemical waste management program for chemical and hazardous waste at Davis-Besse Nuclear Power Station (DBNPS) was developed to insure the disposal of wastes in accordance with all applicable state and federal regulations. Hazardous materials which are transported from the Davis-Besse site are regulated primarily by two federal agencies, the United States Environmental Protection Agency (U.S. EPA) and the Department of Transportation (DOT). The State of Ohio also regulates hazardous materials, but in general, these regulations duplicate the federal regulations.

The waste management program is regulated by the U.S. EPA under the Resource Conservation and Recovery Act (RCRA); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or "Superfund"); and the Toxic Substance Control Act (TSCA). A brief description of these programs is as follows:

- Resource Conservation and Recovery Act (RCRA)

  The Resource Conservation and Recovery Act (RCRA) is the federal law which regulates solid hazardous waste. Solid waste is defined as any solid, liquid, semi-solid or contained gaseous material. The major goals of RCRA are to establish a hazardous waste regulatory program to protect human health and the environment and encourage the establishment of solid waste management systems, resource recovery systems, and resource conservation systems.

  The heart of RCRA is the hazardous waste management program. The intent of this program is to control hazardous wastes from the time they are generated until they are properly disposed, commonly referred to as "cradle to grave" management. Anyone who generates, transports, stores, treats or disposes of hazardous waste is subject to regulation under RCRA.

- Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

  The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or "Superfund") became law in 1980. The primary reason for the establishment of this law was to create a federal authority and source of funding for responding to spills and other releases of hazardous materials into the environment. Superfund established "reportable quantities" for several hundred hazardous materials. Spills exceeding the reportable quantity are reportable to the EPA. Superfund also regulates the cleanup of abandoned hazardous waste disposal sites.

  Amendments to Superfund in November, 1986 established new programs for dealing with emergency preparedness and community right-to-know (Superfund Amendments and Reauthorization Act of 1986 - SARA).

- Toxic Substance Control Act (TSCA)

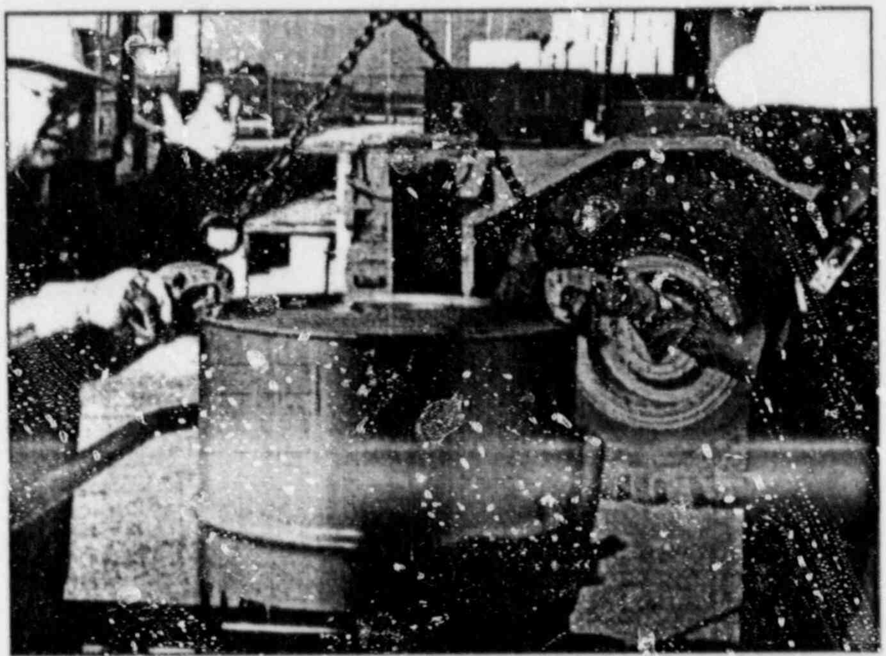


Fig. 8-1: Davis-Besse carefully packages and labels all hazardous materials prior to shipment.

The Toxic Substances Control Act (TSCA) was enacted in 1976 to provide the EPA with the authority to require testing of new chemical substances for potential health effects before they are introduced into the environment and to regulate them where necessary. This law would have little impact on utilities except for the fact that one family of chemicals, PCB's (polychlorinated biphenyls), has been singled out by TSCA. This has resulted in an extensive PCB management system, very similar to the hazardous waste management system established under RCRA, has resulted.

The transportation of hazardous chemicals and chemical waste are regulated under the Transportation Safety Act of 1976. These regulations are enforced by the Department of Transportation (DOT) and cover all aspects of transporting hazardous materials, including packing, handling, labeling, marking, and placarding.

For DOT purposes, the term "hazardous material" encompasses a wide range of materials including explosives, compressed gases, flammable materials, oxidizing materials, irritants, corrosive materials and radioactive materials. Hazardous wastes are covered by the DOT regulations.

Under RCRA, there are essentially three categories of waste generators:

- Large Quantity Generators - 1000 kilograms (2200 lbs/month) or more.
- Small Quantity Generators - Less than 1000 kilograms (2200 lbs/month).
- Conditionally Exempt Small Quantity Generators - 100 kilograms (220 lbs/month).

Davis-Besse has been designated by the U.S. EPA according to RCRA as a large quantity generator of hazardous waste. This limits the Station to a maximum storage period of 90 days for storage of hazardous waste. This act also mandates other requirements for large quantity generators, such as the use of proper storage and shipping containers, labels, manifests, reports, personnel training, a spill control plan and an accident contingency plan, all of which are part of the Davis-Besse program. The following is completed as part of the hazardous waste management program to insure compliance with the RCRA regulations:

- Weekly Inspections of Hazardous Waste Storage and Accumulation Areas

  The hazardous waste accumulation and storage areas are patrolled by security routinely. The storage sites are inspected on a weekly basis, an inspection log is completed by the person inspecting the sites as well as inspection reports and maintenance work requests as needed. The log sheets and inspection reports are retained for three years. All areas used for storage or accumulation of hazardous waste are posted as such with warning signs.

- Chemical Identification of Unknown Chemicals

  The Hazardous Waste Storage Area contains a section for the segregation of drums with unknown contents. This area is called the Chemical Identification Section. This area is also inspected on a weekly basis and all new additions are identified and sampled to insure proper disposal.

- Written Inspection Reports and Monthly Reports

  All inspections of the hazardous chemical storage and accumulation areas as well as any follow-up action items are reported to upper management. This is accomplished by the use of Monthly Reports of Hazardous Chemicals and Materials and Executive Summaries. All inspection items (deficiencies) of immediate concern are completed and delivered the day of the inspection. During 1987, over 2,300 gallons of hazardous waste, 980 gallons of non-hazardous waste, 7,350 gallons of waste oil, 22,130 pounds of non-hazardous special waste, as well as 84 empty drums were transported offsite for disposal.

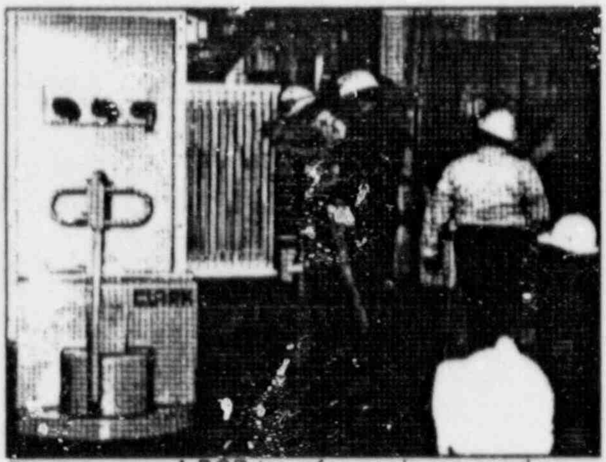



Fig. 8-2: A PCB transformer is removed as part of the Davis-Besse PCB removal program.

To ensure an effective management of PCB, an inspection of the PCB transformers is conducted on a weekly basis. Inspections are conducted to visually inspect transformers for leakage or other potential problems which may exist. There were seventeen PCB transformers located in the

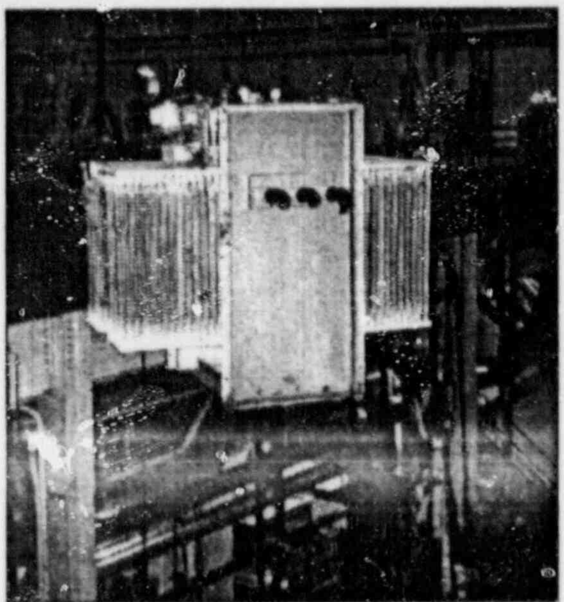


Fig. 8-3: This PCB transformer will be replaced with a newer and safer silicone filled transformer.

Auxiliary Building, Turbine Building and Water Treatment Plant. In 1987, Davis-Besse undertook an aggressive program of reducing the number of PCB transformers onsite. Six of the PCB transformers were replaced with new silicone fluid transformers. Furthermore, the first retrofill cycle for an additional ten transformers was completed. A retrofill cycle involves flushing the PCB fluid out of the transformer, filling it with a solvent, and circulating the solvent for about six months. The cycles are repeated three times and after two years, the process will extract almost all of the PCBs out of the transformers. The seventeenth PCB transformer is planned for removal during the 1988 refueling outage.

The above programs, as well as our commitments to various regulatory agencies, are audited and inspected by various groups and individuals including the following:

- Davis-Besse Quality Assurance Department
- Nuclear Regulatory Commission
- Institute of Nuclear Power Operations
- Environmental Protection Agency
- Private Consultants

These inspections and audits are performed to ensure Davis-Besse maintains our commitment to meet the requirements of Federal and State regulations.

## Controlled Materials Program

### Summary

The Controlled Materials program was established in response to the Institute of Nuclear Power Operations, INPO document CY-703, Control of Chemicals in Nuclear Power Plants. Also, this program contains elements to comply with the Occupational Safety and Health Administration (OSHA), Hazard Communication federal regulation, 29 CFR 1910.1200. The Controlled Materials program consists of controls for ordering, receiving, storing, using, and disposing of chemicals, lubricants, and hazardous materials at the Davis-Besse Nuclear Power Station.

### Background

In June 1985, INPO published Good Practice CY-703, Control of Chemicals in Nuclear Power Plants. This Good Practice described methods to establish, execute, track, and evaluate a chemical control program in a nuclear power plant. Aspects of CY-703 were incorporated into the Davis-Besse Performance Enhancement Plan (PEP) E/SP-1, Hazardous Chemical Safety Program. PEP E/SP-1 included inventorying and classifying chemicals onsite according to the National Fire Protection Association (NFPA), Standard 704, INPO CY-703, and the OSHA Hazard Communication. This step was followed by expanding existing inspections and training sessions. As a final step, materials from the inventory and inspections were submitted to the requirements of the Nuclear Group procedure, NMP-DS-213, "Control of Chemicals, Lubricants, and Hazardous Materials," for approval. On August 24, 1987, OSHA expanded Hazard Communication standard, 29 CFR 1910.1200, to include electric utilities. Under this regulation, we must identify, obtain, and make available to employees, Material Safety Data sheets (MSDS) on hazardous chemicals onsite. Also required is the training of employees on the standard ensuring containers of hazardous chemicals are labeled properly, establishing a written program and training employees on new chemicals in the workplace.

## Controlled Materials Program

Development began in September, 1985 on the Index of Controlled Materials procedure and the supporting manual. By January 1986, the procedure was approved and the program was implemented. The program encompasses procurement, receipt and storage, issue, use, and disposal of materials.

All applicable materials must be approved prior to procurement for use at Davis-Besse. The Bill of Material (BOM) generated through NG-NP-00400, "Materials Management," was revised to include an approval signature block for the Nuclear Industrial Safety and Hygiene Manager. The BOM is a step in the purchasing process. A mechanism was established for approving these materials, through Nuclear Mission Procedure, NMP-DS-213, "Control of Chemicals, Lubricants, and Hazardous Materials." Five departments, Chemistry and Health Physics, Engineering, Industrial Safety and Hygiene, Fire Protection, and Environmental Compliance, must approve each product. Two types of approval can be obtained, the complete formal approval or the temporary emergency approval. The latter approval is in effect for only 48 hours and if the formal approval cycle is not initiated, the material is removed from site. Federal regulations, industry guidelines, and Davis-Besse policies and procedures are considered during the approval process. The material is classified into one of four categories based upon product usage, plant and personnel safety and fire hazards.

Upon receipt, approved materials are stored according to the Nuclear Quality Assurance Manual (NQAM) and associated procedures. Labels, such as material identification, National Fire Protection Association (NFPA), and Category III and IV, are placed on the applicable approved materials.

When the material is issued from the warehouse for use, the user must follow restrictions established for the product. In addition, the user verifies that the product's container has the proper labels and that the intended use matches the approved use of the material. Fire, Industrial Safety and Hygiene, and/or Environmental Compliance department personnel are notified with the Material Notification Form (MNF) for tracking purposes of extremely hazardous substances.

Upon completing work, the controlled material is either returned to stock or disposed of according to Title 10, Code of Federal Regulations, Chapter I, Nuclear Regulatory Commission, and/or Title 40, Code of Federal Regulations, Chapter I, Environmental Protection Agency.

The supporting document, Index of Controlled Materials, contains a complete list of approved controlled materials, spill procedures for various chemical families, lessons learned, and the Controlled Material Information Sheet and Material Safety Data Sheet for each product. The spill procedures consist of station and emergency plan procedures for such materials as oil and toxic gases and toxic liquids. The lessons learned section incorporates Licensing Event Reports, Significant Operating Experience Reports, and general nuclear industry information and guidelines.

The Nuclear Training Division has various sessions addressing aspects of the Controlled Materials Program. These sessions include Resource Conservation and Recovery Act (RCRA) hazardous waste training, OSHA Hazard Communication training on hazardous chemicals, and sessions for various departments covering specific responsibilities outlined in NMP-DS-213. The RCRA and OSHA Hazard Communication training is conducted annually.

Various locations of hazardous chemicals are inspected at least monthly to identify and correct improper storage of materials. Hazardous waste accumulation and storage areas are inspected weekly to ensure adherence to the RCRA regulations for hazardous wastes. During these inspections, items such as required labels, proper usage, and fire hazards, are checked for adherence with the Controlled Materials Program.

This program information will also be used for the Superfund Authorization Act (SARA) of 1986. The first phase of the regulation requires reporting chemicals onsite in quantities of 10,000 pounds or more. In 1988 we will be required to report chemicals of 500 pounds or more. Davis-Besse personnel are involved in the local emergency planning committee.

Upon identifying all chemical products onsite the hazardous waste minimization program will become more effective.

### Conclusion

By December 31, 1987, over 450 products had been approved as controlled materials. The Controlled Materials Program provides a means to prevent the purchase and/or use of a chemical product that could pose a plant and/or personnel safety hazard. This program will ensure adherence to various industry guidelines and federal regulations.

## Asbestos Program

### Summary

The asbestos program was revised to maintain compliance with the Occupational Safety and Health Administration (OSHA) federal regulation, 29 CFR 1926.58, Occupational Exposure to Asbestos, Tremolite, Anthophyllite, and Actinolite. Equipment insulation was randomly sampled and analyzed to determine the amount and location of asbestos. The sampling was performed because the construction of the power station was started several years prior to implementation of the federal regulations restricting the use of asbestos containing materials.

### Description


Fig. 8-4: A worker is fitted with a personal air monitor to measure fiber concentration during asbestos insulation removal.

The procedure on asbestos handling exists at Davis-Besse to protect the health of employees and ensure proper disposal of asbestos waste. This procedure was revised to reflect the recent changes in the OSHA regulations. The procedure identifies the responsibilities of an asbestos competent person and a qualified asbestos removal team, in addition to other departmental responsibilities. The competent person must have attended and passed an approved course in asbestos abatement and received a certificate from the Ohio Department of Health. The removal team must meet medical surveillance, respirator fit test, and training requirements prior to removing asbestos containing materials.

The equipment and pipelines wrapped with insulation were randomly sampled by taking a core sample about one and one-half inches by one and one-half inches. These samples were sent to an outside laboratory, Clayton Environmental Consultants, Incorporated, located in Novi, Michigan. This laboratory is both National Institute of Occupational Safety and Health (NIOSH) and Environmental Protection Agency (EPA) accredited to perform asbestos fiber identification. Clayton used the polarized light microscopy (PLM) method in accordance with EPA protocol to analyze the bulk samples.

Fifty percent of the large components and five percent of the small components sampled were found to contain asbestos, as follows:

- Chrysotile asbestos

  Minimum = 1%
  Maximum = 69%

- Amosite asbestos

  Minimum = 1%
  Maximum = 41%

*Note: Only a small percent of asbestos containing components had this type of asbestos.*

The remaining non asbestos samples contained a mixture of cellulose, wollastonite, mineral wool, fiberglass, and/or a trace of synthetic fibers. These results will be issued to specific site personnel in the Asbestos Insulation Locations Manual.

Since the equipment and pipelines were only randomly sampled, a polarized light microscope was purchased and a Nuclear Health and Safety Division employee was trained on proper analysis of samples. This will facilitate the quick analysis of samples taken for maintenance work of equipment not analyzed previously.

With the change in OSHA asbestos regulations, the removal techniques used at Davis-Besse were altered to meet the OSHA requirements. This included purchasing negative pressure air units, glovebags, tools, High Efficiency Particulate Air (HEPA) vacuum filters, encapsulant, sprayers, and asbestos protective clothing and respirators. The training program for Davis-Besse employees was revised to include asbestos information and a practical on the use of glovebags, setting up the regulated work area, personal and work area air monitoring, and use of protective clothing and equipment.

PHOTO: COURTESY OF USFWS

# APPENDICES

# APPENDICES


| | |
|---|---|
| Appendix A: | 1986 Ohio Department of Health Annual Report |
| Appendix B: | Interlaboratory Comparison Program Results |
| Appendix C: | Data Reporting Conventions |
| Appendix D: | Program Deviations |
| Appendix E: | Glossary |
| Appendix F: | Data Tables |
| Appendix G: | Hourly Meteorological Data Listing for 1987 |


*Note: Appendices A-D, F and G not included in the softcover edition of the Annual Environmental Operating Report. For more information, contact the Environmental Compliance Department, Davis-Besse Nuclear Power Station, 5501 North State Route 2, Oak Harbor, OH 43449, (419) 249-5000, Extension 7146.*

# GLOSSARY

## A

**activation products** Radioactivity that is created when stable substances are bombarded by ionizing radiation.

**ALARA** Acronym for "As Low As Reasonably Achievable," a basic concept of radiation protection that specifies that radioactive discharges from nuclear plants and radiation exposure to personnel be kept as far below regulatory limits as feasible.

**alpha particle** A positively charged particle ejected from the nuclei of some radioactive elements.

**atom** The smallest particle of an element that cannot be divided or broken up by chemical means. It consists of a central core called the nucleus, which contains protons and neutrons. Electrons revolve in orbits in the region surrounding the nucleus.

## B

**background radiation** The radiation in man's natural environment, including cosmic rays and radiation from the naturally radioactive elements, both outside, and inside the bodies of humans and animals. It is also called natural radiation.

**beta particle** A charged particle emitted from a nucleus during radioactive decay, with a mass equal to 1/1837

**beta particle (continued)** that of a proton. A negatively charged beta particle is identical to an electron. A positively charged beta particle is called a positron. Large amounts of beta radiation may cause skin burns, and beta emitters are harmful if they enter the body. Beta particles are easily stopped by a thin sheet of metal or plastic.

## C

**charged particle** An ion. An elementary particle carrying a positive or negative electric charge.

**containment** The provision of a gastight shell or other enclosure around a reactor to confine fission products that otherwise might be released to the atmosphere in the event of an accident.

**control location** A sample collection location generally more than 5 miles away from Davis-Besse. It is used to measure the normal background radiation levels.

**control rod** A rod, plate, or tube containing a material such as hafnium, boron, etc., used to control the power of a nuclear reactor. By absorbing neutrons, a control rod prevents the neutrons from causing further fission.

**cooling tower** A heat exchanger designed to aid in the cooling of water that was used to cool exhaust steam exiting the turbines of a power plant. Cooling towers transfer exhaust heat into the air instead of into a body of water.

**cosmic radiation** Penetrating ionizing radiation, both particulate and electromagnetic, originating in outer space.

**critical group** The segment of the population that could receive the greatest dose.

**critical organ** The body organ receiving a radionuclide or radiation dose that results in the greatest overall damage to the body.

**critical pathway** — The exposure pathway that will provide, for a given radionuclide, the greatest dose to a population, or to a specific segment of the population.

**curie (Ci)** — The basic unit used to describe the intensity of radioactivity in a sample or material. The curie is equal to 37 billion disintegrations per second, which is approximately the rate of decay of 1 gram of radium. A curie is also a quantity of any radionuclide that decays at a rate of 37 billion disintegrations per second. Named for Marie and Pierre Curie, who discovered radium in 1989.

## D

**daughter products** — Isotopes that are formed by the radioactive decay of some other isotope. In the case of radium-226, for example, there are 10 successive daughter products, ending in the stable isotope lead-206.

**dose** — A quantity (total or accumulated) of ionizing radiation received. The term "dose" is often used in the sense of the exposure dose, expressed in roentgens, which is a measure of the total amount of ionization that the quantity of radiation could produce in air. This should be distinguished from the absorbed dose, given in rads, that represents the energy absorbed from the radiation in a gram of any material. Furthermore, the biological dose, given in rem, is a measure of the biological damage to living tissue from the radiation exposure.

**dose rate** — The radiation dose delivered per unit of time. Measured, for example, in rem per hour.

## E

**electromagnetic radiation** — A travelling wave motion resulting from changing electric or magnetic fields. Familiar electromagnetic radiations range from x-rays (and

**electromagnetic radiation (continued)**
gamma rays) of short wavelength, through the ultraviolet, visible, and infrared regions, to radar and radiowaves of relatively long wavelength. All electromagnetic radiations travel in a vacuum with the velocity of light.

**electron**
An elementary particle with negative charge and a mass 1/1837 that of the proton. Electrons surround the positively charged nucleus and determine the chemical properties of the atom.

**element**
One of the 103 known chemical substances that cannot be broken down further without changing its chemical properties. Some examples include hydrogen, nitrogen, gold, lead, and uranium.

**exposure**
The absorption of radiation or ingestion of a radionuclide. Acute exposure is generally accepted to be large exposure received over a short period of time. Chronic exposure is exposure received during a lifetime.

**external radiation**
Exposure to ionizing radiations when the radiation source is located outside the body.

## F

**fission**
The splitting of a nucleus into at least two other nuclei and the release of a relatively large amount of energy. Two or three neutrons are usually released during this type of transformation.

**fission gases**
Those fission products that exist in the gaseous state. Primarily the noble gases, (krypton, xenon, radon, etc.).

**fission products**
The nuclei (fission fragments) formed by the fission of heavy elements, plus the nuclides formed by the fission fragments' radioactive decay.

**fuel assembly** A cluster of fuel rods (or plates). Also called a fuel element. Many fuel assemblies make up a reactor core.

**fuel rod** A long, slender tube that holds fissionable material (fuel) for nuclear reactor use. Fuel rods are assembled into bundles called fuel elements or fuel assemblies, which are loaded individually into the reactor core.

## G

**gamma ray (gamma radiation)** High energy, short wavelength electromagnetic radiation ( a packet of energy) emitted from the nucleus. Gamma radiation frequently accompanies alpha and beta emissions and always accompanies fission. Gamma rays are very penetrating and are best stopped or shielded against by dense materials, such as lead or uranium. Gamma rays are similiar to x-rays, but are usually more energetic.

## H

**halflife** The time in which half the atoms of a particular radioactive substance disintegrate to another nuclear form. Measured halflives vary from millionths of a second to billions of years. Also called physical halflife.

## I

**indicator location** A sample collection location generally within 5 miles of Davis-Besse. It is used to measure the effects of Davis-Besse on the surrounding environment.

**internal radiation** Nuclear radiation resulting from radioactive substances in the body. Some examples are iodine-131 found in the thyroid gland, and strontium-90 and plutonium-239 found in bone.

**ion** An atom that has too many or too few electrons, causing it to be chemically active; an electron that is not associated (in orbit) with a nucleus. (See ionization.)

**ionization** The process of adding one or more electrons to, or removing one or more electrons from, atoms or molecules, thereby creating ions. High temperatures, electrical discharges, or nuclear radiations cause ionization.

**ionizing radiation** Any radiation capable of displacing electrons from atoms or molecules, thereby producing ions. Examples: alpha, beta, gamma, x-rays, neutrons, and ultraviolet light. High doses of ionizing radiation may produce severe skin or tissue damage.

**isotope** One of two or more atoms with the same number of protons, but different numbers of neutrons in their nuclei. Thus, carbon-12, carbon-13, and carbon-14 are isotopes of the element carbon, the numbers denoting the approximate atomic weights. Isotopes have very nearly the same chemical properties, but often different physical properties (for example, carbon-12 and carbon-13 are stable, carbon-14 is radioactive.)

## J K L

**lower limits of detection** The smallest amount of sample activity that will give a net count for which there is a confidence at a predetermined level that the activity is present.

## M

**micro-** A prefix that divides a basic unit into one million parts.

**microcurie** A one-millionth part of a curie.

**milli-** A prefix that divides a basic unit by 1000.

**millirem** A one-thousandth part of a rem.

| | |
|---|---|
| **monitoring** | Periodic or continuous determination of the amount of ionizing radiation or radioactive contamination present in an occupied region, as a safety measure, for purposes of health protection. |

## N

| | |
|---|---|
| **neutron** | An uncharged elementary particle with a mass slightly greater than that of the proton, and found in the nucleus of every atom heavier than hydrogen. |
| **noble gas** | A gaseous chemical element that does not readily enter into chemical combination with other elements. An inert gas. |
| **nucleus (or atomic nucleus)**<br><br>**nuclei (plural)** | The small, central, positively charged region of an atom that carries essentially all the mass. Except for the nucleus of ordinary hydrogen, which has a single proton, all atomic nuclei contain both protons and neutrons. The number of protons determines the total positive charge, or atomic number; this is the same for all the atomic nuclei of a given chemical element. The total number of neutrons and protons is called the mass number. |
| **nuclide** | A general term referring to all known isotopes, both stable (279) and unstable (about 5000), of the chemical elements. |

## O P

| | |
|---|---|
| **pico-** | A prefix that divides a basic unit by one trillion. |
| **picocurie** | One-trillionth part of a curie. |

## Q R

**radioactivity** The spontaneous emission of radiation, generally alpha or beta particles, often accompanied by gamma rays, from the nucleus of an unstable isotope.

**radionuclide** A radioisotope.

**radon (Rn)** A radioactive element that is one of the heaviest gases known. Its atomic number is 86, and its mass number is 222. It is a daughter of radium.

**reaction** Any process involving a chemical or nuclear change.

**rem** Acronym for roentgen equivalent man. The unit of dose of any ionizing radiation that produces the same biological effect as a unit of absorbed dose of ordinary x-rays.

## S

**survey** A study to (1) find the radiation or contamination level of specific objects or locations within an area of interest; (2) locate regions of higher-than-average intensity; i.e., hot spots.

**survey meter** Any portable radiation detection instrument especially adapted for inspecting an area to establish the existence and amount of radioacitve material present.

## T

**terrestrial radiation** The portion of natural radiation (background) that is emitted by naturally occurring radioactive materials in the earth.

**tritium** A radioactive isotope of hydrogen (one proton, two neutrons). Because it is chemically identical to natural

**tritium (cont'd.)** hydrogen, tritium can easily be taken into the body by any ingestion path. Decays by beta emission. Its radioactive halflife is about 12-1/2 years.

## U V W

**whole-body exposure** An exposure of the body to radiation, in which the entire body rather than an isolated part is irradiated. Where a radioisotope is uniformly distributed throughout the body tissues, rather than being concentrated in certain parts, the irradiation can be considered as a whole-body exposure.

## X Y Z

**X-rays** Penetrating electromagnetic radiation (photon) having a wavelength that is much shorter than that of visible light. These rays are usually produced by excitation of the electron field around certain nuclei. In nuclear reactions, it is customary to refer to photons originating in the nucleus as gamma rays, and to those originating in the electron field of the atom as x-rays. These rays are sometimes called roentgen rays after their discover, W. K. Roentgen.

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