Preliminary Draft

Survey of Documents Concerning the Operation of Pilgrim Nuclear Power Station

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This is a report regarding the operating history and current status of Pilgrim Nuclear Power Station (PNPS) as contained in documents located in the Local Public Document Room of the Plymouth Public Library as well as documents obtained via the Freedom of Information Act by Daniel Burnstein. The emphasis of this report is on radiological controls and management of radioactive materials that may affect the public health and safety. This report is by no means a description of all the events that have occurred at the plant, due to the incompleteness of the documents as well as the provision of 10 CFR 2.790(b), which allows the public utility to request that the NRC withhold records and correspondence from the Public Document Room. Even given the limited availability of reports regarding the operation of the plant, there is adequate evidence to demonstrate that for most of the time the plant has been operating there have been open pathways for the unplanned release of long-lived radioisotopes such as Cs-137, Co-60, Mn-54, and Cs-134. In addition, the technical specifications regarding release of 1-131 have been exceeded on numerous occasions. Although the management of PNPS has been largely inadequate, the cause of most of these problems has been the failure of mechanical components in the systems that deal with radioactive effluents prior to release to the environment or packaging as waste to be shipped offsite.

Operation of a Boiling Water Reactor

In order to understand the importance and consequences of mechanical failures in a nuclear power plant, it is necessary to describe basic nuclear power generation and the systems that treat both the liquid and gaseous radioactive effluents that are produced during normal plant operation prior to either release to the environment or shipment offsite. Nuclear power plants are similar to conventional power plants in the sense that they both produce electrical energy by generating steam that turns a turbine that turns a generator. In conventional power plants, steam is produced by burning fossil fuels to boil water. In a nuclear power plant, heat is produced by atomic fission. The fuel used in nuclear reactors such as the one at PNPS is ceramic uranium pellets. The pellets contain a higher proportion of radioactive U-235 than is found in nature, and are said to be "enriched". When an unstable U-235 nucleus is struck by a neutron, it is fragmented into two new radioactive atoms, called fission products. The process also causes neutrons to be released as well as radiation and heat. This is the source of heat in a nuclear reactor. The neutrons produced can in turn interact with other U-235 nuclei, causing them to split. When this process is sustained, it is called a chain reaction, and is a source of heat as well as radiation and radioactive fission products. An isolated uranium fuel pellet is unlikely to support a chain reaction since the neutrons produced travel away very rapidly and are so small they are unlikely to interact with other uranium nuclei. The neutrons must be "slowed down to increase their chances of interacting. In addition, a higher density of U-235 is needed to increase the number of neutrons produced by fission. In commercial nuclear power plants these two conditions are met in the following way: the uranium fuel pellets are loaded into tubes called, cladding made from a zirconium alloy, and the tubes are arranged in a geometrical configuration which optimizes the fission probability. The tubes filled with uranium fuel pellets are referred to as fuel rods. The fission events occur within the fuel pellets contained in the fuel rods. The neutrons produced by the fission process are so small they can get out of the pellets and through the tubes. In order to recapture the neutrons, the fuel rods must be immersed in a material that will act to slow them down. This material is chosen to have a mass as close to that of the neutron as possible. The reason for this is purely mechanical. When one moving object strikes another, the maximum amount of momentum is transferred to the second one if the two objects have close to the same mass. Water is composed of hydrogen and oxygen. Hydrogen has an atomic mass very close to that of a neutron. Oxygen is also a light element, so the arrangement of fuel rods is immersed in water, to slow down the neutrons and make them available for further fission interactions. The fuel rods and water are contained in the reactor vessel. The water is heated by the fission and so both cools the reactor core and is the source of steam needed to run the turbine, so it serves several very important purposes.

In the process of nuclear fission, some of the radioactive fission products produced in the fuel pellets diffuse out of them. They can diffuse through the cladding as well and may enter the reactor water. Another way fission products enter the reactor water is through defects caused by corrosion in the fuel cladding. Some of the important fission products produced are cesium-137, iodine-131, xenon-133, krypton-85, and strontium-90. The neutrons in the reactor water interact in other ways besides being slowed down by the hydrogen and oxygen atoms. Some of the neutrons are captured by gas molecules in the water and the molecules become radioactive in the process. There are small metallic particles present in the reactor water which originate in the piping and valves that comprise the system which carries steam produced in the reactor to the turbine through the condenser back to the reactor vessel. Some of the metallic particles are bombarded by neutrons in the reactor and subsequently become radioactive. The radioactive products formed by neutron bombardment of non-radioactive elements are referred to as activation products. Examples of activation products are cobalt-60, cobalt-58, iron-59, manganese-54, and zinc-65.

During normal plant operation, the steam produced in the reactor is transported to the turbine by a system of pipes and valves. After the steam turns the turbine, it is condensed back into water in the condenser, and re-circulated back to the reactor. At the same time radioactive gases (off-gases) produced in the fission process are removed from the condenser and enter the augmented off-gas system where they are held for 30 minutes to allow short half-life radioactive gases to decay, followed by filtration prior to release to the environment via the Main Stack. In order to reduce the radioactivity in the reactor water and to minimize sludge build-up in the reactor vessel, some of the water is diverted from circulation and purified by a two stage system. The first stage consists of a filter that removes radioactive particles suspended in the water. Subsequent to filtration the water is directed through ion exchange resins where radioactive elements diluted in the water are removed chemically. In the course of normal operation, the ion exchange resin becomes saturated with radioactive particles and loses its efficiency, so it is backwashed and ultrasonically cleaned to remove the high levels of dissolved solid waste. After being regenerated in this manner, it is returned to its demineralizer and placed back in service. Each condensate demineralizer is targeted to undergo backwashing and ultrasonic resin cleaning every five days under normal operating conditions. This places each demineralizer in service for about 30 days before the ion exchange resin is completely spent and must be transferred to the radwaste facility to be treated and solidified for shipment offsite. The sludge trapped in the filters is disposed of in the same fashion. More than 50 shipments of radioactive waste are transported either to Barnwell, SC or Richland, WA by tractor trailer every six months when the plant is operating. The integrity of the systems that remove radionuclides from effluents prior to release to the environment is of great importance to the public health and safety. These systems form the barrier to the release of excessive amounts of radionuclides to the environment under normal operating conditions. Malfunctions of these systems can result in the release of fission and activation products to the environment. The next section describes the normal operation of the systems employed to clean the air and water prior to release. Malfunction of these systems resulted in unplanned releases of long-lived isotopes from PNPS over nearly a ten year period and excessive releases of radioactive iodines and particulates for several years of plant operation. There is no evidence of calculations of offsite doses due to these unplanned releases having been performed on a cumulative basis. Moreover, the systems employed to measure the radioactivity exiting the plant may be quite insensitive to detecting the presence of long-lived isotopes in radioactive effluents. In addition, there is evidence that the calculated dose estimates due to plant effluent releases may be unrelated to actual doses due to the microclimate and other meteorological conditions where the actual conditions deviate substantially from those used to make the dose estimation.

Description and Normal Operation of Systems that limit and Control the Release of Radioactive Effluents

Mathematical models and calculations have been developed to set limits on the quantities of radionuclides that can be released to the environment. The validity of these models and calculations and the integrity of the physical systems that control and measure radioactive releases constitute the barriers that prevent excessive releases. A list of these barriers and their functions are as follows:

1.) Technical specifications concerning maximum release rates of various radionuclides:

The technical specifications of maximum allowable release rates for radionuclides are developed utilizing mathematical models and site-specific meteorological and topographic data to estimate the dose to a member of the public due to plant releases by various pathways. The release rate is calculated so that a maximally exposed individual does not exceed NRC exposure limits to the public. The input parameters in the calculation include average prevailing wind speed and direction, site elevation, elevation and topography of the surrounding area, average atmospheric conditions, proximity of the stack to the nearest plant boundary, average precipitation, average disintegration energy, and the biological concentration of isotopes in various organisms. It should be stressed that the choice of parameters has a great effect on the maximum release rate since the nature of the processes regarding doses of radiation are highly nonlinear. Conversely, if actual environmental conditions deviate greatly from those used in the calculation, doses to the public will be very different from the estimated ones. The Technical Specifications regarding allowable release rates of iodine and particulates at the stack were revised to avoid frequently exceeding those specifications by revising parameters in the calculation of dose estimates to a member of the public during 1975.

2.) Radiation monitoring systems:
Radiation detectors are located at every exit point from the plant of gaseous radioactive effluents. These detectors monitor the gross gamma radiation of gaseous effluents as they pass by. These readings are monitored and recorded in the control room, and when the radiation level approaches release limits, either the effluents can be diverted to another system for further processing, or the power level of the reactor can be reduced in order to reduce the amounts of radioactivity produced. The radiation detectors are sensitive only to the total amount of radiation impinging on them, they don't differentiate between one isotope and another, since there are substantial assumptions regarding short half-lives of isotopes entering the systems. One fundamental limitation to measuring gamma radiation levels exiting the plant ventilation systems is that a relatively large amount of a long half-life isotope would result in a very small perturbation in the total amount of radiation detected, since the decay rate is so much lower compared to short half-life isotopes. In this way, a leak of long half-life isotope could go undetected by a radiation detector. The use of chemical and gamma spectrographic analysis is designed to augment the stack radiation monitoring program.

3.) Chemical and gamma spectrographic analysis techniques used to estimate release rates of individual nuclides: Periodic sampling and analysis techniques are employed to determine the relative abundance of various isotopes that are being released. This is very important since the biological action and possible impact is quite different for different isotopes. The way that this is carried out is that radioactive effluent is sampled by systems that employ filters and charcoal to draw air through them. After a given period of time, the contents of the filters and charcoal are analyzed by measuring the radioactive decay rate as a function of disintegrating energy. Since isotopes decay by emitting radiation of characteristic energies, the amount of a given isotope present in the sample can be estimated by the magnitude of the number of disintegrations at characteristic energies. The uncertainties associated with this method are that in general isotopes emit a spectrum of radiation frequencies, and in a case where there are a large number of unknown isotopes present in the sample, the energy peaks can overlap for different species and it may not be possible to assay many isotopes with any accuracy. Another problem that can occur is that the efficiency of the charcoal absorber is strongly the function of relative humidity, so in the cases of high humidity, the amount of given isotope present in the charcoal may not at all reflect the concentrations present in the sampled effluent. Detectors used to perform these measurements have non-uniform responses to different energy peaks, and calibration of these sensitive instruments should be conducted frequently. Finally, the raw measurements from these instruments are entered into equations to estimate actual release rates, so the associated Uncertainties may be quite high.

4.) Integrity of the fuel assemblies, especially the cladding into which the fuel pellets are loaded:

As explained above, the fuel rods consist of enriched fuel pellets loaded in cladding. The fission products produced are proportional to the rate of fission events which is proportional to the operating power level of the reactor. Ordinarily they are kept from entering the reactor water by the fuel cladding. When the fuel cladding suffers from corrosion, fission products are free to enter the reactor coolant and circulate with the reactor water. Consequently the concentrations of fission products in the gaseous and liquid effluents become elevated, and if the effluent cleanup systems either don't exist or lack the capacity to filter out the increased concentrations of fission products, the release of radioactivity to the environment will increase above normal operating levels. Pilgrim Nuclear Power Station exceeded its technical specifications with regard to releases of radioactive iodine and particulates on numerous occasions due to a combination of fuel cladding failure which resulted in high levels of radioactive iodine (a fission product) in the reactor coolant and mechanical component failure in the systems designed to reduce the levels of radioactivity in the gaseous and liquid effluents.

5.) The Augmented Off-gas System:

The purpose of the augmented off-gas system is to reduce the radioactivity of gases that are removed from the radioactive steam that turns the turbine in the condenser. This system was not included in the original plant designs, since the plant owners insisted that they would never be operating under conditions where the amount of radioactivity in the off-gas would be high enough to exceed technical specifications regarding release limits, so that no equipment would be required to reduce the release levels, The Atomic Energy Commission pointed out that technical specification limitations on releases are not to be interpreted as normal operating specifications, and that equipment to reduce the levels of radioactivity would be required to operate at substantially lower release rates. After two years of operating the plant, and three years of installation and testing, the augmented off-gas system came on-line in December of 1974. The augmented off-gas system consists of a 30 minute delay line to allow for the decay of short half-life isotopes, a pre-filter to remove radioactive particulates, "and several charcoal absorbers to remove radioactive iodines. The augmented off-gas system is housed in the Retention Building. Leaks in the augmented off-gas system result in increased radioactivity in the Retention Building. The Retention Building is vented to the Reactor Building Ventilation System, so leaks in the augmented off-gas system are manifested as increased radioactivity exiting the Reactor Building Vent.

6.) The Main Stack dilution system:

In order to reduce the concentration of radionuclides in gaseous effluents exiting the Main Stack, clean air is used to dilute the radioactive effluents prior to release.

7.) The Reactor Water Cleanup System:

The purpose of the Reactor Water Cleanup System is to reduce the amount of radioactive fission and particularly activation products from the re-circulating reactor water to minimize crud loading of the reactor vessel and attendant radiation exposures, as well as keep the reactor water conductivity at reasonable levels. This helps to limit the amount of radioactivity released in the event of a Loss of Coolant Accident. As the reactor water is re-circulated from the condenser, part of it is diverted from the primary cooling system to be purified. The reactor water cleanup system consists of filters to remove particles suspended in the water followed by treatment using ion exchange resins to remove dissolved radioactive elements from the water. The treatment system that utilizes ion exchange resins for chemical removal of radioactive elements is called the condensate demineralizers (designated A-G). The reactor water, diverted on its way back to the reactor vessel from the condenser, is added to the condensate demineralizers in service. While water is being added to the demineralizers, air is vented out the system, so that when the system is filled, it is airtight. Each tank has a vent line which is closed by a tank vent block valve when the system is filled with water. The vent line from each tank is connected to a common vent header, which is closed by the vent header valve. The procedure for ensuring that all the air is out of the system is to fill the demineralizers until some water floods up the tank vent line and into the vent header to a point in the header before the vent header valve where a sensor is located that detects the presence of water. When the water reaches the sensor, it sends a signal to the control panel to alert the operator to stop adding water to the system. The operator then closes the tank vent block valves and the vent header block valve and the demineralizers are operated. The air that was bled off in the process of filling the system then goes to a gas scrubber, since it is likely to contain radioactivity, and from the gas scrubber it enters the ventilation ductwork of the reactor building, leading to the reactor building ventilation system where it is filtered and vented to the atmosphere. In cases where the reactor building vent effluent radioactivity monitor detects elevated amounts of radioactivity, indicating the release limits are being approached, an alarm sounds, and the operator isolates the reactor building ventilation system and initiates the Standby Gas Treatment System, which filters air from the reactor building ventilation system prior to releasing it through the Main Stack. Eventually the resin loses its ability to remove particles dissolved in the water, and is transferred to the Cation tank for backwashing to clean it or it may be ultrasonically regenerated. After several regenerations it is completely spent and is transferred to the Radwaste System to the Resin Storage Tank for dewatering and packaging for off-site disposal. The procedure for transferring resin is the same as filling the tanks, and they have similar venting systems that tie into the gas scrubber. The reason for going into so much detail regarding the normal operation of these systems is that failure of the valves that control these systems and procedural deficiencies have resulted in accidental releases of radioactive water and resin to the environment over nearly a decade during the normal operation of the plant. Due to the high levels of radiation emitted close to the operation of these systems, they must be controlled remotely and operators must rely on instrumentation to determine when to start and terminate operations. It is only during fuel outages that components of these systems can be inspected directly after the radioactivity has decayed sufficiently to safely allow human presence.

8.) The Liquid Radwaste Treatment System:

9.) The Reactor Building Ventilation System:

10.) The Standby Gas Treatment System:

History and Consequences of Valve Failures and Procedural Inadequacies in the Operation of the Condensate Demineralizer System

Having described the normal operation of the condensate demineralizer system, this section will describe a sequence of events that occurred when mechanical components in the system failed. The information presented here is taken from a Boston Edison memo, several Licensee Event Reports from PNPS to the NRC, and an NRC inspection report. First a narrative description of the sequence of events as described in these documents is presented, followed by a chronological citation of each of these documents and the specific incidents they detail. During the process of filling the condensate demineralizer tanks, failure of the sensor to alert the operator that the system is filled with water results in water filling the vent header past the open vent header block valve (which is open during filling to allow air to be bled off) all the way up to the gas scrubber. In the gas scrubber, there is a dump valve which is supposed to drain water from the gas scrubber. When the dump valve fails, the water and resin beads from the condensate demineralizers are able to flood right up and into the ventilation ductwork of the Reactor Building. From there the water is evaporated and vented to the atmosphere taking with it any radionuclides in the water. Once the water dries, some of the resin beads remain in the ductwork and some of them are drawn through the filters in the reactor Building ventilation system, where the resin can clog the filters, resulting in bypass of the filters by gaseous radioactive effluents and radioactive resin. The end result is that untreated gaseous radioactive effluents and resin beads contaminated with long-lived nuclides such as CO-60, Cs-137, Cs-134, and Mn-54 are released to the environment. A similar process occurs in the Standby Gas Treatment System every time it is operated, thus contaminating that system with resin beads as well. Another way water has migrated into the Reactor Building ventilation system has been the failure of the tank vent block valves to close completely. In this case, operation of the condensate demineralizers results in water and resin being deposited in the vent header. The resin and water are subsequently carried up through the gas scrubber to the Reactor Building Ventilation System on the pathways described above. Similar valve failures have occurred in the vent valve associated with the cation regeneration tank, and was suspected to have occurred with the resin storage tank vent valve. The sequence of these failures is as follows.

December 7, 1977: referred to in NRC Inspection Report 50-293/81-04

Summary: On December 7, 1977 spent resin spilled into the Resin Addition Room, seeped under the room doors and outdoors, flowing into a storm drain located approximately 30-40 feet from the door. The storm drain flows directly into the plant discharge canal, so that the resin and water were released directly into the bay. The incident was caused by the failure of operators to recognize that the 2-inch block valve downstream of the resin hopper had to be closed following a resin addition. The written procedures for performing a resin addition did not include closing the block valve. The corrective action for the event was a commitment by Boston Edison to train the operators in the requirements for adherence to procedures.

January 17, 1981: Preliminary Notification of Event or Unusual Occurrence: PNO-I-(not numbered) dated 1/19/81

Summary: On January 17, 1981 water and spent resin were accidentally spilled in the resin Addition Room while spent resin was being transferred from the “B” Condensate Demineralizer to the Cation Tank for backwashing. Approximately 100 cubic feet of spent resin and 150 gallons of water seeped under the door of the building and spilled outdoors. The cause of the accident was a valve out of alignment in the clean resin addition line.

June 8, 1981: Inspection 50-293/81-04 conducted February 3-5, 1981.

Summary: A review of the events of January 17, 1981 revealed that a nuclear plant operator noticed material seeping out under the door of the Resin Addition Room. The “G” Condensate Demineralizer had been taken out of service for backwashing approximately one-half hour prior to the discovery of the spill indicating that it had been in progress for that amount of time. When the spill was discovered it was observed to be flowing and was about 2-3 feet from the door of the Resin Addition Room. The plant operator who observed the spill notified the Reactor Control Room as well as an onsite snow plow crew and plowed a snow dam to try to contain the spill. The Watch Engineer was notified of the spill, he obtained keys to the Resin Addition Room and proceeded to the area of the spill. Remembering the spill of December, 1977, and the high probability of flowing under the snow to the storm drain, he entered the Resin Addition Room and closed the two condensate transfer valves through which the spent resin was flowing into the hopper from the cation regeneration tank. The regeneration tank contained resin that was being backwashed. The Watch Engineer sustained spent resin contamination of his hair and shoes as a result of walking through the resin and water. The radiation measurements made on spent resin outside the Resin Addition Room indicated contact gamma dose rates of 300 mR/hr and beta dose rates of approximately 1OOO mR/hr. Within 5 minutes after the valves were closed by the watch Engineer, personnel arrived to begin cleaning up the resin and water to prevent it from entering the storm drain. No radiation surveys were performed during the initial cleanup to ensure that personnel performing the cleanup would not be overexposed. The inspector's review indicated that the resin spill was a result of valves being left open during resin addition. This was due to a procedural deficiency regarding operation of the condensate demineralizer system. The inspector noted that the written procedure did not alert operators that failures to close valves opened during loading of resin would result in a spent resin spill. In addition, the inspector noted that the procedure check off lists did not identify the 2-inch block valve downstream of the resin addition hopper, or the condensate transfer valves which bypass the block valve, or specify the required position of these valves to prevent a spill. The inspector noted that these and other procedural deficiencies were the cause of the December, 1977 spill and apparently no action had been taken by Boston Edison to correct them since that accident. With respect to radiation exposures sustained by workers, whole body counts of workers involved in shoveling the resin were not performed. This was warranted since airborne activity levels were not measured during the initial cleanup.

June, 1979: LER 79-020/03L-0 referred to in Technical Review No. AEOD/T307

Summary: Resin intrusion into the Standby Gas Treatment System was discovered.

September 27,1981: Inspection Report 50-293/82-01 referred to in Report 50-293/82-20

Summary: Dry radioactive resin was found in the "B" Standby Gas Treatment System on September 27,1981.

September, 1981: referred to in Report 50-293/82-20

Summary: In September, 1981 the Reactor Building Contaminated Area Exhaust Filters were found to be bypassing, due to improper filter fit and degradation and were replaced. This allowed untreated gaseous effluents and most likely resin beads to be vented to the environment.

January 28, 1982: NRC Memo dated 2/12/82 describing telephone 1nversation with PNPS Radiation Protection Manager (RPM)

Summary: 80-100 gallons of spent resin was discovered and removed from the Standby Gas Treatment System (SBGTS). The RPM stated that he thought that the resin had originated in the Reactor Building Ventilation System. The resin was subsequently bagged and drummed, but the drums were not labeled, the radiation area was not posted, and contractors working in the area of the SBGTS the next day were not informed of the radiation levels of the resin scattered on the floor in the area of the cleanup. The foreman of the contractor work crew refused to continue working when his self- reading dosimeter indicated 10 mrem exposure.

March 2, 1982: Boston Edison Memo-Title: Bead Resin in Standby Gas Treatment System PNPS File Number: TCH 82-73

Summary: This memo details all the mechanical and instrumental failures leading to the water and resin flooding up into the reactor building. The memo states: “The bead resin found in the SBGT system recently (giving rise to Rad Deficiency Report #82-1-30-2) is not something new. This situation has existed for almost as long as this station has been operating.” The memo details the numerous times the vent heater ruptured from overpressurization, causing operators to suspect that at least one of the condensate demineralizer vent blocker valves was leaking. Furthermore when the vent blocker valves were inspected during the refuel outage, it was discovered that 6 out of 7 were leaking, so that resin could migrate into the vent header.

Another problem described was the failure of sensing instrumentation that indicates when the tanks are filled. “The sensing instrumentation has never worked properly. Since the vent block valve is open during this step to allow the vented air to go to the gas scrubber and subsequently to the contaminated exhaust system, this means that the water could flood the header all the way up to and into the gas scrubber; not only could, but did- all the time!” “By design the gas scrubber has an automatic dump valve which works off a switch on the level indicator which is supposed to open and drain the scrubber when the water level reaches a prescribed limit. There are a number of problems associated with this dump valve operation, not the least of which is its complete failure to operate in numerous occasions. When this valve fails to open, the water continues filling the scrubber and floods right up to and into the ventilation ductwork of EL 23’of the reactor building carrying any resin that may have been residing in the venting system due to the leaking vent valves described earlier. Since the reactor building contaminated exhaust ties into the standby gas treatment system, it is very easy to get resin into that system any time it is operated, once the water in the ventilation ductwork dries up.” The fact that radioactive resin beads and water flooded into the ductwork of the reactor building ventilation system as a matter of routine operation of the condensate demineralizer system for nearly as long as the plant was operating demonstrates that long-lived isotopes contained in the water and resin were accidentally vented to the atmosphere during normal plant operation. In addition, the presence of the additional humidity brought by the water flooding the system in all likelihood severely impaired the ability of the filters to perform as designed, impairing their ability to remove radioactive iodines and particulates from gaseous effluents. The charcoal absorbers utilized to estimate the release of halogens and particulates were probably also rendered ineffective, resulting in an underestimation of releases.

June 11, 1982: Preliminary Notification of Event or Unusual Occurrence- PNO-I-82-42 Subject: release of Spent Resin

Summary: On June 11, 1982 spent resin was found on the ground near the turbine building. Surveys identified contamination of the roofs of the Turbine, Off-Gas and Re-Tube Buildings. Contamination was also found on the ground within the site. Contamination levels ranged from 20-30,000 dpm/100cm2 with maximum contamination up to 100,000 dpm/100c2. Gamma isotopic analysis of the resin identified primarily long-lived radionuclides (CO-60, Cs-137. Cs-134, and MN-54). The resin was thought to have been released from the reactor building vent duct.

June 11, 1982: License Event Report dated June 9, 1982

Summary: On June 11, 1982 the "A" Standby Gas Treatment System was declared inoperable based on low flow test data. The cause was determined to be clogged filters due to radioactive resin beads from the condensate demineralizer system vents migrating into the duct work of the SGTS.

June 14, 1982: Preliminary Notification of Event or Unusual Occurrence—PNO-I-82-42A. Subject: Release of spent resin update.

June 14, 1982: Preliminary Notification of Event or Unusual Occurrence~-PNO-I-82-42A. Subject: Release of spent resin update

Summary: PNPS believes the origin of the radioactive resin released to the environment is resin that entered the ventilation ducts from the condensate demineralizer system during resin backwashing via the Cation Regeneration Tank Vent. In addition, resin from defective condensate demineralizer vent valves may also have been released prior to their repair during the September 1981-March 1982 refueling outage. This means that radioactive resin had been released to the environment prior to September 1981 and was not detected until another release occurred in June, 1982. There is a strong likelihood that older released resin had migrated away from the release site during the months it went undetected. Moreover if spent resin was released to the environment, then certainly water containing the same radionuclides was released at the same time or prior to it.

July 7, 1982: Inspection report by the NRC of PNPS dated July 7, 1982

Summary: This summary will only detail items directly related to the uncontrolled release of radioactive resin, although there are several incidents related to high radiation levels occurring in the plant due to a stuck Traversing In-Core Probe, and the lack of control of high radiation areas during this mishap.

A report of the initial investigation revealed that the source of the spent radioactive resin was via the Reactor Building Vent, the Reactor Building Contaminated Exhaust System and the Condensate Demineralizer-Resin Regeneration System during backwashing evolutions. Radioactive resin was cleaned from the 'A' train of the SGTS and the filters plugged with resin were cleared. Resin was cleaned from the ‘B’ train of the SGTS as well. This means that the radioactive resin had migrated into both trains of the SGTS. The SGTS has two trains because it is a redundant system, and one train must always be functional for plant operation. Other unnamed filters were cleaned of radioactive resin as well.

July 8, 1982: NRC Memo: Generic Implications of the Release of Spent Demineralizer Resins from Pilgrim, Unit No.1. PNO-I-82-42/42A

Summary: This memo details the circumstances and regulatory environment that would allow flooding of the Reactor Building Ventilation System with spent resin and water resulting in deterioration and ultimately failure of filters so that resin was released to the environment. Special attention is paid to the condition of filters. The memo states:

“It is probable that water entered the ventilation exhaust ducts along with the resins noted in (1), above. While it is not known if this water was significantly radioactive, the presence of the water may have been a factor in the deterioration of filters and filter frames."

“An IE Health Physics appraisal team visited Pilgrim in January and February, 1980. The team’s report, dated July, 1980, noted that the prefilters were ‘disintegrating in place’.”

“This situation was apparently not corrected until the refueling outage which began in September, 1981. In fairness to the licensee, though, it should be noted that the pre-filter disintegration was not included as a ‘significant finding’ by the NRC in the appraisal.

“The staff considers that the Pilgrim occurrence has no direct implications as to the integrity of adequately tested and maintained HEPA filters and ESF filters, but, rather emphasizes the need for regular testing and surveillance where a specified level of performance is to be achieved and maintained. The occurrence is, however, a clear demonstration that plant operators cannot neglect HEPA filter systems indefinitely and then expect them to perform as designed.”

“We note, however, that in the present regulatory climate, licensees, in general, have no compelling motivation to perform surveillance which is not formally required of them, especially when inoperability of a system will not lead to noncompliance.” The fact that deteriorating pre-filters were observed during the Pilgrim Health Physics appraisal and that radioactive resins were found to be present in the ventilation exhaust ducts was not evidence that Tech Spec release limits or Appendix I criteria were being exceeded and, therefore, there was no violation of regulatory requirements to initiate corrective action.”

“While the failure or procrastination on the part of the operating plants to regularly test and assure proper functioning of these systems may be interpreted by some parties as failing to provide maximum protection to the environment, making such testing a firm commitment would necessitate a substantial revision in the basic NRC philosophy of plant safety in environmental protection.”

“The licensee and IE have been aware for over two years that radioactive resin beads and fines were present in Pilgrim ventilation exhaust ducts. The same appraisal report, page 55 notes serious deficiencies in the condition of the ventilation exhaust pre-filters and the presence of approx. 6 inches of spilled radioactive (2R/hr) resins on the floor of the room in the Radwaste

Building as well as loose contamination up to 90 mrads/hr on the floor immediately outside that room. In view of the unique and highly visible nature of the resin beads, the rather high radioactive contamination levels associated with the resins and knowledge that resins had been a problem in
several areas of the plant for over 2 years, the Licensee's statement that the resins had probably been released prior to September, 1981, seems to indicate, at best, am absence of recognition of potential problems on the part of plant management. To admit that external plant contamination of this order of magnitude had gone unnoticed and undetected for over 8 months would seem to admit to the existence of inadequacies in the Health Physics Program."

August 5, 1982: Inspection Summary: Inspection on June 11-13, 1982 (Inspection report No. 50-293/82-20)

Summary: An announced inspection occurred to evaluate the response of PNPS to the release of radioactive resin on June 11, 1982. The inspectors toured the site to evaluate the control and extent of the resin contamination. Eight areas of the site were found to be contaminated. They are as follows: The Administration Building Roof with activity levels of 100k-200k dpm, the Turbine. of 100k-200k dpm, the Turbine Building Roof- lOOk dpm, the Augmented Offgas Building- 200k dpm, the Retube Building- 200k dpm, the Main Transformer Area- 1k-25k dpm, Pavement just south of the Augmented Offgas Building, Retube Building, and Main Transformer Area- 20k-80k dpm, and Pavement just Northwest of the Administration Building- 100k-200k dpm. The roof of the Reactor Building was clean, indicating that the source of the release was the Reactor Building Vent.

April 19, 1983: AEOD Technical Review Report AEOD/T307: Condensate Demineralizer Migration Through the Plant Vent and the Standby Gas Treatment System

Summary: This report reviews the safety significance of the June 1982 discovery at Pilgrim that demineralizer resins had migrated throughout the plant contaminated exhaust vent to external plant areas. It details the short-term action taken to preclude further resin migration into the vent system. The cause of the resin migration was noted to be a gas scrubber that. never performed as intended and allowed the flooding to occur. The gas scrubber was disconnected from the ventilation system and the scrubber discharge was rerouted to the Reactor Building Equipment Sump. The sump was not designed for the quantity of air, water, and resin produced by demineralizer backwashing, and the it backed up the drain pathway of the sump into both the HPCI room and the B RHR pump room. Approximately 12 inches of water and resin accumulated in both of those rooms. Given that a recent spill in the HPCI room estimated to be 150 gal. amounted to about 2 inches, then 12 inches of resin and water would be estimated to amount to 900 gallons. The volume of the B RHR pump room is not known at this time.

September 1986:

It was discovered that there was a design flaw in the Standby Gas Treatment System whereby a condition resulting in the degraded performance of one train could result contaminated air bypassing the affected train through the redundant train without filtration to the environment.