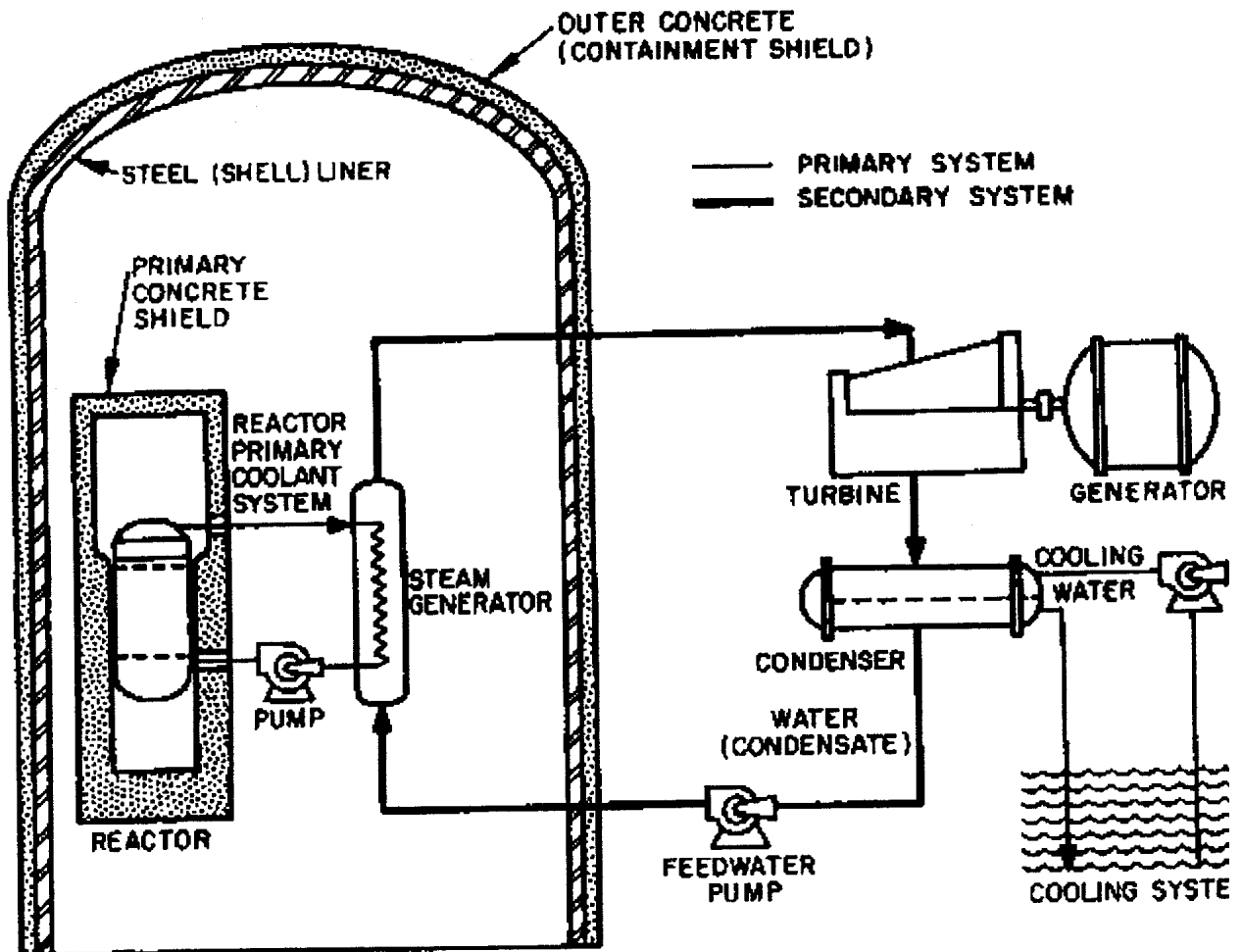




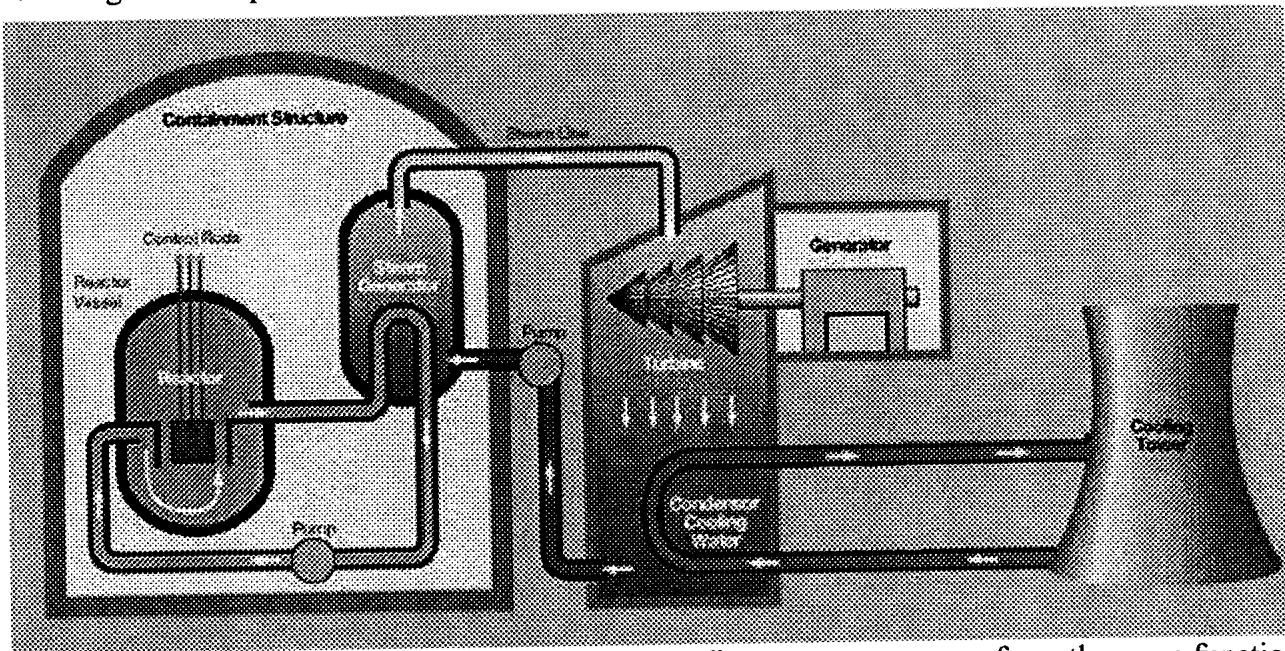
Cooling Water Systems at Nuclear Power Plants

Nuclear power plants in the United States use steam to spin turbines connected to generators that make electricity. Because these plants produce three units of thermal energy in order to make one unit of electrical energy, considerable amounts of waste heat must be discharged to the environment. Nuclear power plants are built next to oceans, lakes, and rivers. These bodies of water provide the cheapest method for removing the waste heat from the nuclear power plants.

There are two ways for nuclear power plants to use water from oceans, lakes, and rivers. The first and simplest way is called once-through cooling. Water is drawn from the nearby ocean, lake, or river and routed through metal tubes inside a large box (labeled condenser in the figure) located beneath the turbine. Steam leaving the turbine flows through the condenser on the outside of the tubes where it gets cooled until it changes back into water. The water inside the tubes, now up to 30°F warmer, gets sent straight back to the ocean, lake, or river. For a large nuclear plant like the St. Lucie plant in Florida, nearly one-half million gallons of water per reactor is needed every minute of once-through cooling.



The second method features one or more cooling towers. Cooling towers reduce the amount of water needed from the nearby ocean, lake, or river by dissipating waste heat to the air as well as to the water around the plant. Water is drawn from the cooling tower, routed through the condenser tubes, and returned to the cooling tower. Air flows through the inside of the cooling tower where it cools the water before it gets taken back to the condenser. Some of the water evaporates and gets carried out the top of the cooling tower with the air. This creates the tell-tale vapor cloud that makes operating nuclear power plants with cooling towers easy to spot from miles away. The only water that is needed from the nearby ocean, lake, or river is make-up needed to replace the evaporated water. In addition, make-up is needed to balance a constant flow of water from the cooling tower back to the ocean, lake, or river to control the chemistry of the cooling water. The amount of ocean, lake, or river water needed to compensate for evaporation losses and chemical control is approximately 30,000 gallons per minute per reactor for a large nuclear plant like the Susquehanna plant in Pennsylvania.



The once-through cooling system and the cooling tower system perform the same function of removing waste heat from the nuclear power plant's condenser. Both methods require water from a nearby ocean, lake, or river. Both methods use multiple screens to limit the amount of debris and aquatic life that is carried into the plant with the water. The outer screens are typically metal bars with wide openings that obstruct large debris like logs and two-liter bottles. The inner screens are also metal bars, but with smaller openings designed to allow water and only small debris and aquatic life to enter.

The once-through cooling system use nearly ten times as much ocean, lake, or river water as the cooling tower system. The once-through cooling system also discharges nearly ten times as much water—and at higher temperature—to the ocean, lake, or river as the cooling tower system.