54. If 1000 kg of soybean oil (triglyceride) is converted to biodiesel, how much revenue would you realize if you sold all of the generated glycerol product at $0.06 per kg glycerol?

a. $6.10

b. $2.37

c. $15.10

d. $1.08

e. $7.04

55. 300 grams of an oil feedstock that is 97% triglyceride undergoes transesterification. The amount of biodiesel formed (in grams) is:

a. 101 g

b. 98 g

c. 215 g

d. 295 g

e. 304 g

56. At the end of transesterification, two layers of product (one layer of biodiesel and one layer of glycerol) are visible if the reactants are allowed to settle in a separatory funnel. If too much ethanol is added, however, there are three layers of product (one layer of biodiesel, one layer of glycerol, and one layer of ethanol). What is the order of product from top to bottom in a separatory funnel when too much ethanol is added and the following notation is used: glycerol = G, biodiesel = B, and ethanol = E.

a. E G B

b. G B E

c. E B G

d. G E B

e. B G E

Work it Out

57. The average weight of a gallon of petroleum diesel is ~7 pounds, yet the fuel releases 22.38 pounds of CO_2 when combusted. This occurs because the carbon in the combusted fuel reacts with atmospheric oxygen. Assuming all of the carbon in diesel fuel is converted to CO_2 during combustion, how many pounds of oxygen are consumed when diesel fuel is combusted?

a. 18.8 lbs

b. 16.3 lbs

c. 27.3 lbs

d. 10.5 lbs

e. 13.8 lbs

Work it Out

Questions 58, 59, and 60 utilize the information present in Tables 1 and 2.

TABLE 1 Current Estimated Per Gallon Production Cost of Soybean Based B100 Biodiesel by Unit for a 7 Million Gallon Plant

Raw Soybean	$2.90
Alcohol	$0.15
Catalyst	$0.08
Energy to run plant	$0.02
Labor	$0.05
Cost of infrastructure	$0.15
Maintenance	$0.04
Administrative costs	$0.02

TABLE 2 Retailer Taxes, Credits, and Transportation Costs for B100 Biodiesel

Tax credit	$1.00 per gallon
State and Federal Tax	$0.43 per gallon
Transportation Costs	$0.10 per gallon

$1.53

58. If the cost of soybeans shown in Table 1 increases by 5%, what is the resulting production cost of a gallon of soybean based biodiesel?

    a. $3.04

    b. $3.41

    c. $4.38

    d. $4.51

    e. $3.56

Work it Out

59. If the producer in Table 1 includes a $0.02 per gallon markup on their produced product for profit, what is the final per gallon biodiesel retailer purchase price taking into account taxes and incentives shown in Table 2?

a. $2.96

b. $3.96

c. $3.98

d. $4.96

e. $2.98

60. If the retailer finds a producer that sells B100 for $2.50 per gallon and the retailer has a price markup of $0.15 per gallon, what is the break even retail price of the sold fuel factoring in the data presented in Table 2?

a. $3.97

b. $3.17

c. $4.18

d. $2.18

e. $2.97

Work it Out

Nuclear Safety —
A Boiling Water Nuclear Reactor's Rankine Power Cycle vs. Coal

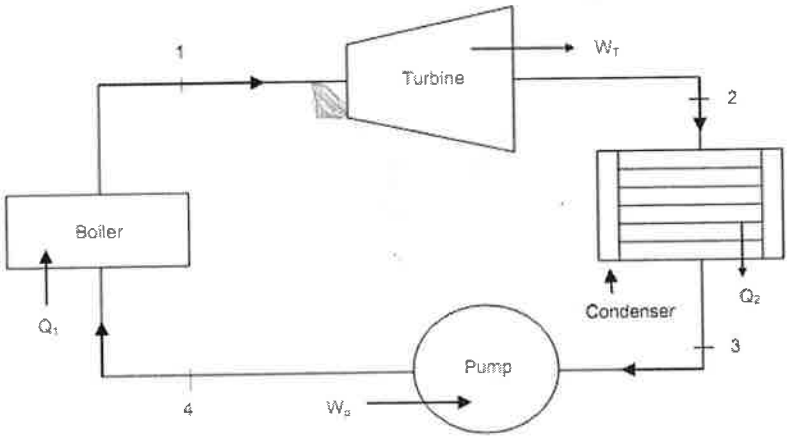
The world needs reliable, cost effective, carbon free energy to meet the future demands of the planet. Nuclear energy is one technology that can provide this energy. It produces large amount of energy, without producing greenhouse gases and operates for 18 to 24 consecutive months without being refueled.

Nuclear energy facilities employ hundreds of highly trained and qualified individuals who must operate these facilities safely 24 hours a day, 365 days a year. These men and women are mainly operators, mechanics and technicians but also include hundreds of engineers, security guards and other support staff. The engineers at a nuclear power plant are responsible for maintaining large mechanical and electric components that allow the reactor to generate electricity safely.

Problem Statement

You are engineering members of a team responsible for maintaining the safe operation of the nuclear power plant while optimizing the water-steam flow through the plant to ensure maximum electricity output.

Heat Transfer in a Power Plant O\



Water is heated in the boiling nuclear reactor (boiler) and turns into steam. That steam spins the turbine which generates electricity. The steam loses some of its energy spinning the turbine and condenses back into water. This water is collected in a tank called a condenser. A pump then moves the water in the condenser by pushing it back into the nuclear reactor to be reheated.

In a perfect world the steam supply system would behave as a Carnot cycle. A Carnot cycle is a system where there are no losses of efficiency and all energy is transferred. This is a theoretical cycle. In reality, all thermal power plants, including a boiling water reactor, are best described as a Rankine cycle. A Rankine cycle has inefficiencies where energy is lost throughout the many steps of transforming the water into steam and back again into water.

The Rankine cycle closely describes the process by which steam-operated heat engines commonly found in thermal power generation plants generate power, regardless of the source of the heat used to heat the water. The source of heat can be a nuclear reaction or burning coal or natural gas. The working fluid in a Rankine cycle follows a closed loop and is reused constantly.

Water is the medium used to transfer the energy from a nuclear reaction in a boiling water reactor to the turbine. Water is capable of retaining energy. The amount of energy is dependent upon the pressure and temperature the water is at any point.

Enthalpy is a quantity equivalent to the total heat content of a system, defined as the internal energy of a system plus the product of pressure and volume. Total enthalpy, H, is measured in energy per unit of time (J/sec). Specific enthalpy (h) is a characteristic of a component of a system, or energy per unit mass (J/kg).

Assumptions and Givens

Temperature of the steam at point 1	T_1	295°C
Pressure of the steam at point 1	P_1	8.0 MPa
Enthalpy of the steam at point 1	h_1	2758 kJ/kg
Temperature of the water at point 2	T_2	41.5°C
Pressure of the water at point 2	P_2	0.008 MPa
Enthalpy of the water at point 2	h_2	1794.8 kJ/kg
Temperature of the water at point 3	T_3	41.5°C
Pressure of the water at point 3	P_3	0.008 MPa
Enthalpy of the water at point 3	h_3	173.88 kJ/Kg
Temperature of the water at point 4	T_4	44.8°C
Pressure of the water at point 4	P_4	8.0 MPa
Enthalpy of the water at point 4	h_4	181.94 kJ/kg
Temperature of the water entering the condenser	T_{in}	15°C
Temperature of the water exiting the Condenser	T^{out}	35°C
Heat into the water from the Boiling Water Reactor	Q_1	Unknown
Heat out of the water through the Condenser	Q_2	169.75 MW
Work of the Pump	W_p	8.06 kJ/kg
Work of the Turbine	W_t	963.2 kJ/kg
Work of the Cycle	W_{cycle}	100.02 MW
Conversions: Watts to Joules		1 W = 1 J/second

Equations for Rankine Cycle Power Plant

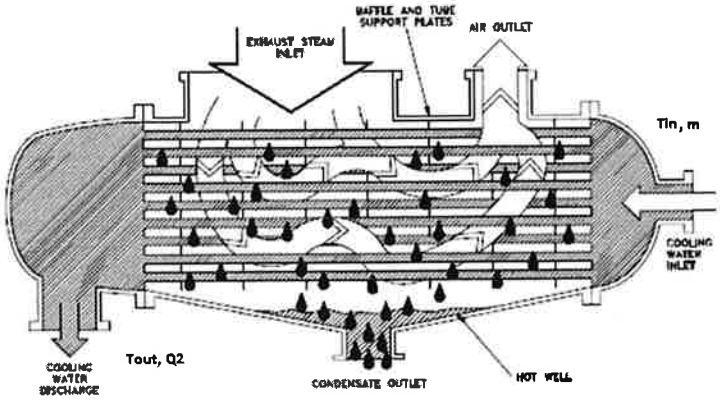
Thermal Efficiency of the Rankine Cycle	$\eta = (W_T - W_P)/Q_1$
Mechanical Power (Work) Absorbed by the Cycle	$W_{cycle} = Q_1 - Q_2$
Mass Flow Rate of Water Through the Condenser	$m_{condensor} = W_{cycle}/(W_t - W_p)$
Back Work Ratio	$BWR = W_p/W_t$
Work of the Turbine	$W_t = m_{turbine}(h_1 - h_2)$
Work of the Pump	$W_p = m_{pump}(h_4 - h_3)$
Heat into the water from the Boiling Water Reactor	$Q_1 = m_{boiling_reactor}(h_1 - h_4)$

Assumptions and Givens

Engineers at a boiling water reactor will look at the efficiency of the plant in multiple ways. One of the comparisons conducted at a boiling water reactor is calculating the Back Work Ratio (BWR) of the thermal system. The BWR is the ratio of pump work required and turbine work generated. Engineers calculate this value to determine how much the pump is reducing the total efficiently of the plant.

Not all of the heat generated in a boiling water reactor is transferred through the turbine to make electricity. All thermal power plants lose some of the energy as the steam and water transfers through the pipes and pumps. This energy is lost to the atmosphere and cannot be recollected. The amount of energy that does successfully become transferred through the turbine as compared to the energy produced in the reactor is called thermal efficiency of the plant.

The condenser in a Rankine Cycle removes heat from the boiler. It accomplishes this by flowing cold water through a tube that shares a pipe wall with the warm water exiting the turbine. As the cold water circulates through the condenser it absorbs heat from the warm water. The amount of heat transferred is directly correlated to the inlet temperature of the condenser water and the rate at which the cold water flows through the condenser.



For this example, assume the rate of flow (m) is the same through all components.

61. What is the Back Work Ratio of the Pump?

    a. 1.60%
    b. -1.60%
    c. 0.84%
    d. 119.5%
    e. 116.5% 62.

Work it Out

62. What is the mass flow rate of the water in the condenser?

a. 2.51×10^5 kg/hour

b. 6.89×10^5 kg/hour

c. 104.73×10^5 kg/hour

d. 3.77×10^5 kg/hour

e. 101.73×10^5 kg/hour

63. What is the thermal efficiency of the Rankine Cycle?

a. 2.7%

b. 37.1%

c. 93.4%

d. 34.9%

e. 43.9%

The cold water entering a condenser comes from either a large body of water or a cooling tower that can remove tremendous amounts of heat very quickly. Sometimes a clog can form in piping that transports this cold water. This will reduce the flow of cold water.

64. Assume the mass flow rate of water in the condenser is reduced to 3.45×10^5 kg/hour due to a clog in the pipe and that the work of the cycle remains constant. What amount of heat can the condenser now remove?

a. 255.34 MW

b. 155.34 MW

c. 919.20 GW

d. 169.75 MW

e. 175.69 MW

Work it Out

Utilities like to keep large, expensive pieces of equipment for as long as they can safely be operated before they are replaced. Engineers sometimes recommend reducing power production in a reactor to optimize the performance of the uranium core. This means the amount of energy entering the boiling water is reduced, but is sufficient enough to turn the water into steam which will spin the turbine and still generate electricity.

65. If the energy created in the boiling water reactor's uranium core is reduced by 9 percent, what is the new mass flow rate the operators must maintain if they wish the energy being removed by the condenser to remain constant?

    a. 162.2×10^3 kg/hour

    b. 5.84×10^5 kg/hour

    c. 89.7 kg/hour

    d. 3.23×10^5 kg/hour

    e. 158.3×10^3 kg/hour

Work it Out

Nuclear power plants require significantly less material (by weight) than power plants that rely on combustion of fossil fuels to produce heat. For these questions, assume that generating enough power to meet demands for a growing city requires the construction of a new power plant. One proposal is to build three power plants: two coal-fired plants and one gas fueled. The larger coal plant is capable of generating 800 MW; the smaller coal-fired plant is capable of generating 400 MW and the gas-fired plant is capable of generating 200MW.

Assumptions and Givens

- The 800-Megawatt plant requires 10,000 Btu of heat input to produce 1 kilowatt-hour of electricity.
- The 400-Megawatt plant requires 10,200 Btu of heat input to produce 1 kilowatt-hour of electricity.
- The 200-Megawatt plant requires 9,000 Btu of heat input to produce 1 kilowatt-hour of electricity.
- Local coal cost $30.00/ton at 12,000 Btu/lb. and 3.2% Sulfur.
- Compliance coal cost $25.00/ton at 9,000Btu/lb. and 0.4% Sulfur.
- Molecular Weight of C = 12, H = 1, S = 32, O = 16
- Coal is all carbon except for sulfur as given
- Natural Gas is 90% CH_4 and 10% CO_2
- Natural Gas cost $2.00/1,000ft^3 at 1,000 Btu/ft^3.
- A plant is assumed 100% efficient if 3,413 Btu produce one kilowatt-hour of power.
- 3413 Btu = 1 kilowatts-hr.

66. Your oven requires 2,000 watts to maintain a heat of 350°F. How much local coal is required to produce the electricity for the 3 hours to cook your Sunday dinner assuming all the power comes from the 400-Megawatt plant?

    a. 5.0 lb

    b. 5100 lb

    c. 6 lb

    d. 0.196 lb

    e. 0.85

Work it Out

67. Assuming local coal is used, how much sulfur dioxide is produced?

a. 326.4 lb

b. 0.1632 lb

c. 0.4864 lb

d. 163.2 lb

e. 0.3264 lb

68. What is the cost of the local coal for the 800 Megawatt and 400 Megawatt plants vs. the natural gas for the 200 Megawatt plant to produce a megawatt of electricity?

a. $12.50, $12.75, $18.00

b. $0.013, $0.014, $4.50

c. $125, $127.50, $180

d. $1,250, $1,275, $180

e. $1.30, $1.40, $4.50

Assumptions and Givens

- The density of natural gas is 0.045lb/ft^3
- A pound of C in natural gas produces about twice as much power as a pound of C in coal.

69. If you are trying to minimize your total CO_2 output while producing 1,200 Megawatts, what should your power distribution be for the 3 plants?

a. 800MW 75%, 400MW 100%, 200MW 100%

b. 800MW 50%, 400MW 100%, 200MW 50%

c. 800MW 100%, 400MW 50%, 200MW 100%

d. 800MW 100%, 400MW 100%, 200MW 0%

e. 800MW 100%, 400MW 75%, 200MW 50%

Work it Out

70. What weight of sulfur dioxide is produced by burning the local and compliance coal?

a. 533 lb SO_2/Mbtu, 890 lb SO_2/Mbtu

b. 533 lb SO_2/Mbtu, 780 lb SO_2/Mbtu

c. 5.33 lb SO_2/Mbtu, 0.78 lb SO_2/Mbtu

d. 0.533 lb SO_2/Mbtu, 0.89 lb SO_2/Mbtu

e. 5.33 lb SO_2/Mbtu, 0.89 lb SO_2/Mbtu

Work it Out

Decay Heat in a Nuclear Power Plant's Spent Fuel Pool

Nuclear energy is one way to produce large amounts of reliable, cost effective, safe electricity. Nuclear power plants generate electricity by fissioning uranium fuel. Fission is the process of splitting a large atom into two smaller atoms by hitting it with a neutron.

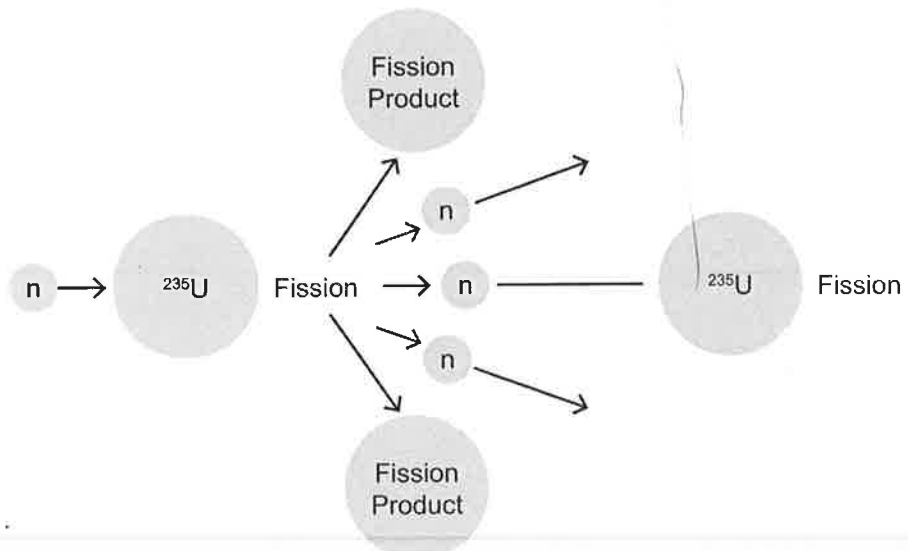
Fission simultaneously produces heat and additional neutrons which can be used to fission the next uranium atom. Nuclear energy does not emit greenhouse gases as it uses fission, not combustion to generate electricity. This means that nuclear energy technology is one way to combat Climate Change.

Nuclear power does however generate used fuel that must be safely stored and ultimately disposed. Used fuel is removed from a nuclear power plant's core typically after 4.5 years of operations. It is then transported to a spent fuel pool where it is stored for 10+ years while it cools enough to be placed into canisters.

The used fuel must continue to be cooled because the uranium fuel will continue to create heat even after being removed from the core. This heat, called decay heat, is the result of radioactive decay. Decay heat occurs naturally from the decay of long-lived radioisotopes that were produced during fission in the uranium fuel.

Fission Process

When uranium atoms fission, it creates two smaller atoms, releases an incredible amount of energy in the form of heat and releases three neutrons. These free neutrons will travel to the next uranium atom, causing that atom to fission. When enough free neutrons are released to create a self-sustaining number of fissions, we call this a chain reaction.



The fission of a single ^{235}U atom yields energy of 193 MeV, or 3.09×10^{-11} J.

One component of nuclear waste is the radioactive fission products, one of which is ^{137}Cs. ^{137}Cs is generated in 5% of the fission events.

Assumptions and Givens

Assume we are working with a nuclear plant that is designed to generate 1000MW of power, and assume the efficiency of the plant is 32%.

1 gallon water = 0.1337ft^3.

1 psi (pound per square inch) = 6.895 kPa

71. What is the rate of heat production (in MW, or megawatts [thermal])?

    a. 3125 MW

    b. 1471 MW

    c. 320 MW

    d. 3200 MW

    e. 6800 MW

Work it Out

Assumptions and Givens

The relationship between mass in grams and mass expressed m atomic units is found using Avogadro's number:

Number of atoms per gram

$$= \frac{N_{Av}}{A} = [0.6022 \cdot 10^{24} \text{ atoms/mol}]/[A \text{ g/mol}] \quad \text{where} \quad A \text{ is the atomic weight of the element}$$

The radioactive decay equation gives the amount of decaying radionuclide present at time t.

$$N(t) = N_0 e^{-\lambda t}, \quad \text{where} \quad \lambda = \frac{\ln(2)}{T_{1/2}} = \frac{0.693}{T_{1/2}}$$

The half-life can be written in terms of the decay constant, or the mean lifetime, as:

$$t_{1/2} = \frac{\ln(2)}{\lambda} = T\ln(2)$$

$T_{1/2}$ is the half-life of the radionuclide.

The activity in disintegrations/second is: $A(t) = N \cdot \lambda = A_0 e^{-\lambda t}$

where A_0 is the initial disintegrations/second (or curies)

The fission reaction rate in a certain reactor core is 3.0×10^{19} fissions/second.

The flow rate through a pipe = cross-sectional area * velocity

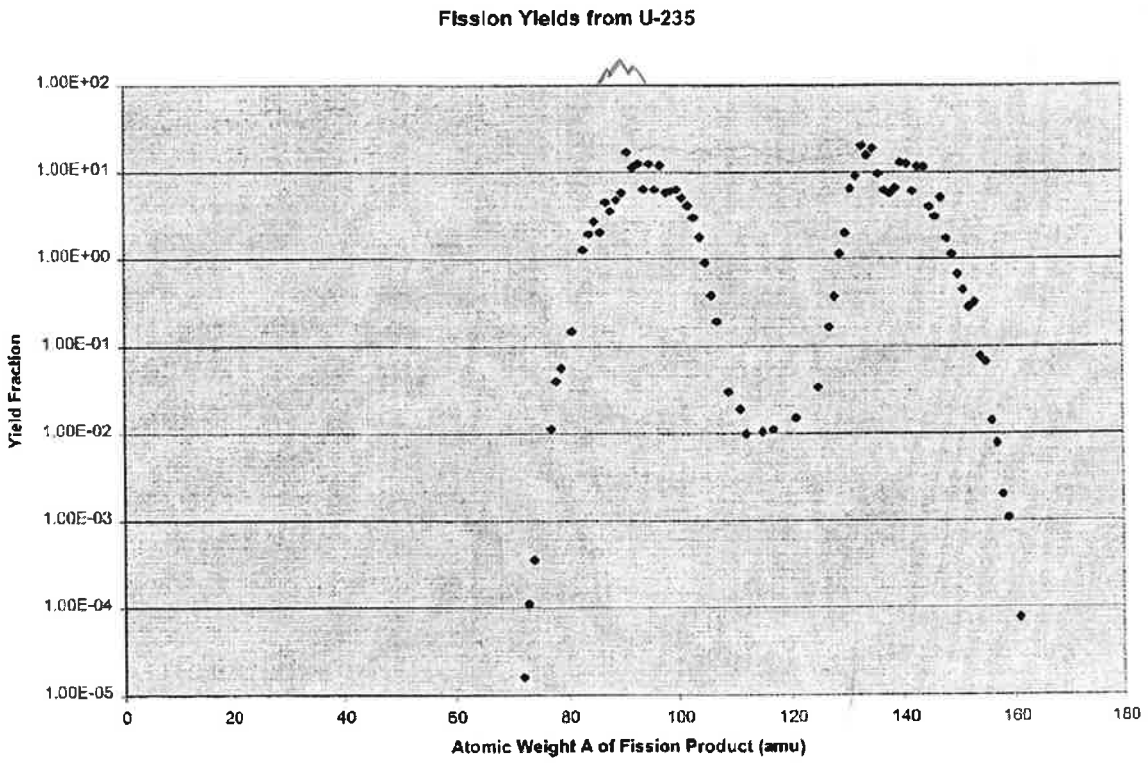
72. The approximate rate of production of ^{137}Cs, in kg/year, is most nearly:

    a. 0.2
    b. 11
    c. 5
    d. 1
    e. 35

Work it Out

Additional Assumptions and Givens

The creation of fission products is the source of a significant portion of radioactive waste. But fission is a process in which one of the products is generally heavier than the other. The generation of fission products is described by the "double-humped fission product curve." This curve is given below:



Seymour Katcoff, "Fission-Product Yields from Neutron-Induced Fission," Nucleonics, Vol.18, No. 11, 201-208 (1960)

73. Which of the following radionuclides would have the greatest rate of production as a fission product?

    a. ^{153}Gd

    b. ^{108}Pd

    c. ^{14}C

    d. ^{90}Sr

    e. ^{226}Ra

Work it Out

Additional Assumptions and Givens

In most power reactors today, the coolant is ordinary water maintained at a high purity. Water at a temperature of 100 °C and a pressure of 5 MPa (megapascals) has a density of 960.6 kg/m^3. In this problem, 500,000 gallons per hour of this water is flowing through a pipe whose inner diameter is 10 inches.

Low-level radioactive waste is predominantly composed of radionuclides whose half-life is 50 years or less. Among the more important of these is ^{137}Cs, whose half-life is 30.2 years. For this problem assume that, at the time of delivery to a low-level waste disposal facility, the activity of a shipment of ^{137}Cs is 20 curies.

74. The velocity of the water, in ft/sec, is:

    a. 2042 ft/sec
    b. 302 ft/sec
    c. 225 ft/sec
    d. 34 ft/sec
    e. 28 ft/sec

75. The length of time that it will take for the activity of this shipment to become 1 curie is most nearly:

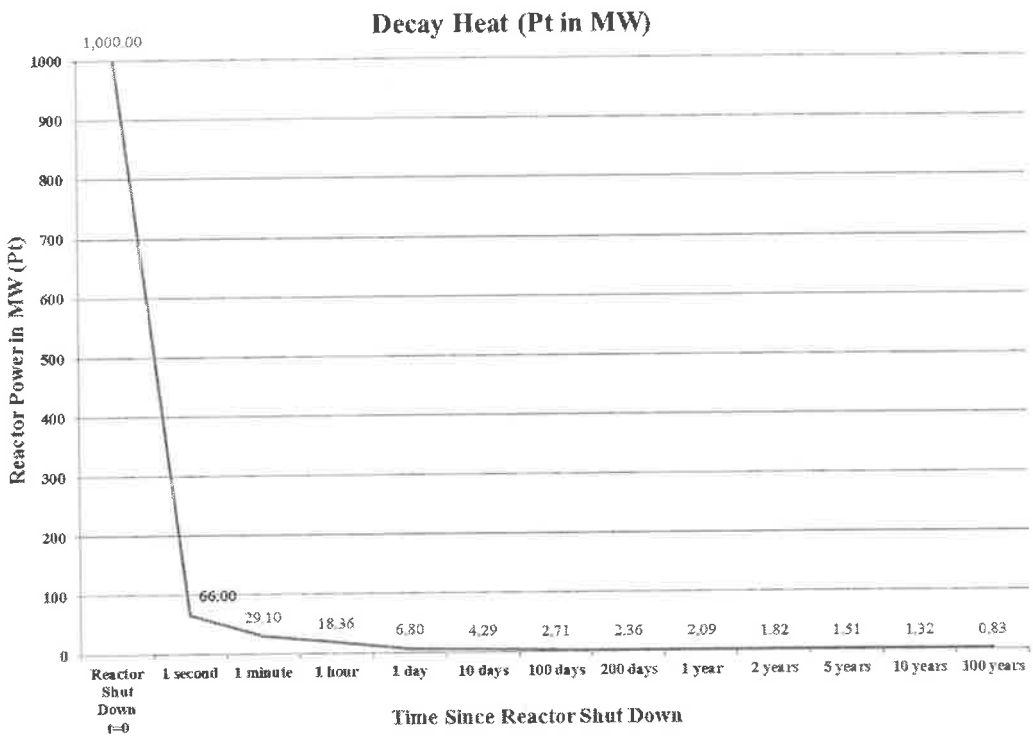
    a. 574 years
    b. 131 years
    c. 91 years
    d. 70 years
    e. 10 years

Work it Out

Decay Heat

Not all uranium atoms fission instantaneously. Some uranium atoms instead become unstable with the extra energy introduced by the neutron collision. Unstable uranium atoms eventually fission; just at a later time.

This delayed fission is what causes uranium fuel to produce additional heat even after the reactor has been shut down. The heat produced by a delayed fission is called Decay Heat. Decay Heat typically produces heat in a range from 1% to 6% of the original reactor's power, depending on the time since the reactor shut down.



Spent Fuel

The used fuel is moved to a spent fuel pool where it waits for the decay heat to dissipate. These spent fuel pools must have adequate cooling systems to remove the decay heat. If adequate cooling is not available, there is a possibility that the water in the spent fuel pool will heat up to the point where it begins to boil.

Boiling water is a problem for a spent fuel pool. Water converts to steam when boiled. Converting water to steam reduces the amount of water left in the spent fuel pool. Water is needed in a spent fuel pool to 1) cool the used fuel and 2) shield workers from radiation.

Problem Statement

You are a team of engineers at a nuclear power plant responsible for ensuring the safe operation of a nuclear power plant's spent fuel pool. The nuclear reactor at your plant operates with 240 fuel assemblies and discharges (replaces) a third of those assemblies every 18 months to the spent fuel pool.

The spent fuel pool is a perfect rectangle and is twice as long as it is wide and is currently housing 380 used fuel assemblies. The newest 80 assemblies were removed from the reactor 1 year ago and the oldest 80 assemblies were removed from the nuclear reactor 5.5 years ago.

A large earthquake has occurred that has damaged the pump for your spent fuel pool. Operators at the nuclear power plants immediately inspected the spent fuel pool after the earthquake dissipates. No debris is seen in or around the spent fuel pool. The water in the pool is sitting stagnant at 12 inches from the top of the pool. Operators have determined by this that the pool is not leaking water.

Additional visual inspections by the operators determine that the used fuel assemblies are safely sitting in the storage rack at the bottom of the pool. An operator notices that the small pump used to cool the spent fuel pool is cracked and no longer able to operate. The operator reports this problem to your engineering team. You must determine if the used fuel is safely being stored.

Assumptions and Givens in a Used Fuel Pool

Decay Power	$P_f(t)$	Power generated by used fuel in a spent fuel pool.
Decay Heat Constant (Time is in seconds)	A	0.066 sec
Density of Water in Spent Fuel Pool	ρ	1.918 slugs/ft^3
Depth of the Spent Fuel Pool (feet)	H_{pool}	31 ft
Height of a Used Fuel Assembly	$H_{fuel\ assembly}$	12 ft
Latent Heat of Vaporization	Lv	2,260,000 J/kg
Mass of Pool Water	$m_{pool\ water}$	TBD
Number of Used Fuel Assemblies in the Spent Fuel Pool		380
Reactor Power at Shutdown	P_0	1,000 MW
Specific Heat of Water	C_p	4186 J/kg • °K
Temperature of the Spent Fuel Pool in Fahrenheit (before the earthquake)	T_{pool}	120°F
Time to Boil	t_{Boil}	TBD
Time to Uncover	$t_{Uncover}$	TBD
Volume of Pool Water	$V_{pool\ water}$	TBD
Water Constants	1 gallon	3.7851 kg
Water Constants	1 gallon	0.13368 ft^3
Width of the Spent Fuel Pool (feet)	W_{pool}	40 ft
Depth of the Spent Fuel Pool (feet)	D_{pool}	31 ft
Width of a Used Fuel Assembly	$W_{fuel\ assembly}$	1 ft
1 slug = 14.59 kg		
Farenheit to Kelvin = 9/5(K − 273) + 32		

Equations for Decay Heat in a Used Fuel Pool

Power Produced by a Reactor Full of Fuel at a Certain Time After the Reactor Shuts Down	$P_f(t) = P_0 A t^{-0.2}$
Watt	3600 J/hour
Absolute Temperature	273.15°K
Energy Needed to Heat Water	$Q = mC_p\Delta T + mL_v$
Energy Needed to Boil Water	$E_{Boil} = \rho V C_p (T_{boil} - T_i)$ $E_{Boil} = Pf_{uel}\, t$

Assumptions and Questions

Your team can have a portable pump installed and operating at the spent fuel pool within three days. The maintenance department is estimating they need seven days to order and install a brand new pump to replace the damaged pump. Your team must determine if you need to have the portable pump installed. To do this you need to know how long before 1) the water begins to boil (t_{Boil}) and 2) before the fuel is left uncovered by water ($t_{Uncover}$).

To determine these two times you will need to complete a number of other calculations. First you must determine how much decay heat is being produced in the spent fuel pool.

76. How much power (decay heat) is produced by the spent fuel in the pool?

    a. 0.7 MW
    b. 3.5 MW
    c. 2.3 MW
    d. 1.5 MW
    e. 5.1 MW

77. How many gallons of water are in the spent fuel pool?

    a. 718,133 gal
    b. 91,440 gal
    c. 684,021 gal
    d. 96,000 gal
    e. 71,833 gal

78. What is the mass of the water in the spent fuel pool?

    a. 2.59×10^6 kg
    b. 2.72×10^6 kg
    c. 91,440 kg
    d. 24,158 kg
    e. 3.59×10^6 kg

Work it Out

79. How long until the water in the spent fuel pool begins to boil in hours?

a. 157.1 hours

b. 68.32 hours

c. 24.1 hours

d. 0.16 hours

e. 35.3 hours

80. How many gallons of water does each spent fuel rod displace when added to the spent fuel pool?

a. 12 gal

b. 31.7 gal

c. 45.4 gal

d. 89.8 gal

e. 112 gal

Work it Out

Task 1: Energy and Environment: Biodiesel

Biodiesel is a renewable fuel produced from vegetable oils and animal fats. While biodiesel is considered a sustainable fuel, there are challenges to running the US transportation sector on biodiesel. What are the key social, economic, and environmental concerns associated with higher rates of biodiesel adoption?

Use the space below for notes or outlines. Use Part 2 answer sheet(s) for the final essay.

Task 2: Hydropower

Hydroelectric dams are considered by many to be clean, emissions free, sources of renewable energy. However, sustainability of dams has been called into question over the past two decades. What are some important drawbacks to hydroelectric dams that have social and environmental consequences?

Use the space below for notes or outlines. Use Part 2 answer sheet(s) for the final essay.

Task 3: Smart Homes

According to the U.S. Energy Information Administration, the average household in the United States consumes roughly 10,837 kWh per year-or 903 kWh per month. With the increase in the building of smart homes the idea of energy efficiency has experienced tremendous growth.

Evaluate the overall impact of the advancements in smart homes and the all-in-one integration of energy efficient systems in these residential settings.

Use the space below for notes or outlines. Use Part 2 answer sheet(s) for the final essay.

Task 4: Concentrating Solar Power

The energy generated from concentrating solar power stations is increasing as a percentage of total energy generation in the United States, albeit much smaller than other sources such as coal, natural gas, nuclear, and hydro. Continued growth is expected as costs drop and new legislation pushes the energy industry to adopt more low-emission (or no emission) forms of generation. Describe the benefits and drawbacks of installing a large number of concentrating solar power stations.

Use the space below for notes or outlines. Use part 2 answer sheet(s) for the final essay.

Task 5: Wind Power

Wind power offers a number of advantages as an energy option and currently is viewed as the "fastest-growing energy source in the world" (Office of Energy Efficiency and Renewable Energy, 2013). Its benefits are both environmental and economic; it is clean, renewable, and sustainable.

Present the rationale for wind power being both environmentally and economically valuable as part of an overall energy strategy.

Use the space below for notes or outlines. Use Part 2 answer sheet(s) for the final essay.