Name: _____ Date: _____ Class: _____

Nuclear Power Plant Virtual Field Trip Handout Answer Key

Site 1: Let's Learn the Basics at https://www.learnwithrichie.com/ks3/about-nuclear-energy

1. List the steps of creating electricity using a steam turbine.

1) Boil water to create steam, 2) Use the steam to spin turbine blades, 3) The spinning turbine turns a generator, which creates electricity, 4) Send the electricity to transformers that produce the correct voltage, which produces a constant supply of power.

2. Read the "What is nuclear fission?" section. What is a chain reaction?

When a moving neutron hits the nucleus of a uranium atom—which contains both protons and neutrons in its nucleus—it splits it into several smaller fragments and releases more neutrons. These neutrons hit more uranium nuclei, repeating the cycle in what is called a **chain reaction**. This produces a large amount of heat energy. The heat energy produced is used to boil water, which makes steam, which turns turbines that generates electricity.

3. Why is uranium good in making electricity?

Benefits from electricity made from uranium (nuclear energy) are that it does not produce any carbon dioxide (CO_2 pollution into the atmosphere) and gives us electricity whenever we need it.

4. Describe how to make electricity from uranium.

Uranium is mined from the Earth. A chemical called fluorine is added to the uranium, which turns it into uranium hexafluoride (UF_6)—a yellow powder. The yellow powder is heated in large ovens to turn it into a gas. Then the UF_6 gas is enriched to turn it into a nuclear fuel.

Two types of isotopes make up uranium—U235 and U238. For nuclear fission to work, the uranium must contain lots more U235 so it is "enriched," which means the amount of U235 in the uranium is increased or strengthened, often by the use of centrifuges. As a comparison, if you were making a chocolate cake and you continued to add cocoa powder, you would be "enriching" (or increasing/strengthening) the chocolate flavor. Then electricity is produced via nuclear fission.

5. List the steps of uranium enrichment.

1) UF_6 gas is fed into centrifuges, 2) the centrifuges spin to separate the isotopes (U238 is heavier than U235) and the portion with the most U235 is put into another centrifuge and the process is repeated, 3) when the right balance of isotopes is achieved to make the best fuel possible, the enriched UF_6 passes through compressors into product containers, and 4) UF_6 is cooled to become a solid material.

Site 2: Let's Tour a Plant at http://www.energytrendsinsider.com/2010/07/01/a-tour-inside-vermont-yankee-nuclear-power-plant/ (Vermont Yankee Nuclear Power Plant)

6. What kind of security exists in nuclear power plants?

Tight security. No photographs are permitted of security measures like fences, camera and screening equipment). All visitors and their bags go through a screening process (like at airports); then they put on visitor badges, have their palms scanned and enter via a subway-like turnstile. Next, visitors are informed of their responsibilities and each given a hard hat, safety glasses, earplugs and two radiation monitors. One monitor provides a live reading of exposure while in the plant; the other records a more precise measurement that is mailed to them later.

7. What is a scheduled outage period?

Every 18 months for about 30 days, the reactor is shut down so contractors can come to the plant to perform maintenance and swap out fuel bundles.

8. Define: *spent fuel pool*

Spent fuel pools are where the spent fuel from a plant's entire operational history is kept. Spent fuel rods are still extremely radioactive so for safety reasons they are stored in water to keep them cool. The spent fuel bundles (canister-shaped) are submerged in big concrete pools that are about 40 feet deep (tall as a four-story building) and several feet thick.

9. Watch the **video**. What strikes you?

Answers will vary. Possible examples: It's noisy! It's big!

10. How long will the materials in dry storage be radioactive?

The nuclear materials will be radioactive for more than 100,000 years. This radioactive waste is stored outside in above-ground concrete and steel containers (dry casks) that are expected to last 100 years.

11. How many gallons of water does the plant use every minute?

365,000 gallons a minute

12. What else did you learn that you found interesting?

Answers will vary. Possible examples: It's really hot—100+ degrees in the reactor building! On most days, not many people are in the big power plant. Most power plants are located near rivers because they need so much water for the cooling process. Armed security guards patrol the plant grounds. At most plants, the cooling towers are hyperboloid shaped. People are scanned for radiation exposure when they leave the building. From her tour, the journalist writing the story got a reading of 0.7 millren of radiation exposure. It must be a dangerous job to move the spent fuel bundles into the pool and dry storage containers. Other radioactive waste accumulates, too, like office supplies and radiation suits.

Site 3: Let's Identify Some Major Concepts at https://en.wikipedia.org/wiki/Nuclear_power_plant and https://en.wikipedia.org/wiki/Nuclear_power

13. Define: containment

Since nuclear fission creates radioactivity, the reactor core is surrounded by a protective shield like a dome of concrete. This **containment** absorbs radiation and prevents the radioactivity material from being released into the environment.

14. Identify some debate issues surrounding nuclear power: pros and cons.

Pro claims: Safe and sustainable energy source with no carbon and air pollution emissions, decreases dependence on imported energy sources, supplies dispatchable electricity

Con claims: Threats to people and environment when processing, transporting and storing radioactive materials and waste; risk of nuclear weapons and terrorism; health risks and environmental damage from uranium mining; complex reactors are susceptible to human error (accidents); carbon and pollution are byproducts of mining and decommissioning

15. Describe something you found interesting about the **history** or **future** of nuclear power:

Answers will vary. Possible examples: The discovery of nuclear power led to atomic bombs and is how we came by the phrase "Atomic Age." In 1945, science writers projected that future cars would run on pellets of atomic energy instead of gasoline and we would have nuclear-powered artificial hearts and heated swimming pools. Fuel rods are typically used for about six years before they are "spent" and stored. Most new nuclear power plants are going up in China where they need to generate more electricity but don't want any more pollution from coal plants.