M

Demonstrate understanding of redundancy and reliability in technological systems Achievement Standard 91360

Introduction:

In this document, I will be discussing the redundancies and reliabilities of your average nuclear power plant. I will cover the 5 tasks below which will cover the redundancies and reliabilities well. Below is an image of a power plant in Japan:

1. Explain the importance of redundancy in the development of the ……………..

When nuclear power plants first became an option for countries around the world to use as a power generation source, the possible dangers of something going wrong in these plants

)

where always apparent. And it is for that reason that the safety considerations of nuclear plants have been increasing exponentially in its 60 years of use. In this time, there have only been 3 major incidents. These include Three Mile Island in 1979, Chernobyl in 1986, and Fukishima in 2011. All these disasters were dealt with promptly due to the countries knowledge of the devastation a nuclear disaster can create. This made redundancies in nuclear power plants very important.

If a nuclear disaster where to occur, the cost for dealing with the issue would be very high. This is motive for countries with nuclear power plants to increase the redundancy and reliability of these plants, so they can provide maximum power with the least cost possible.

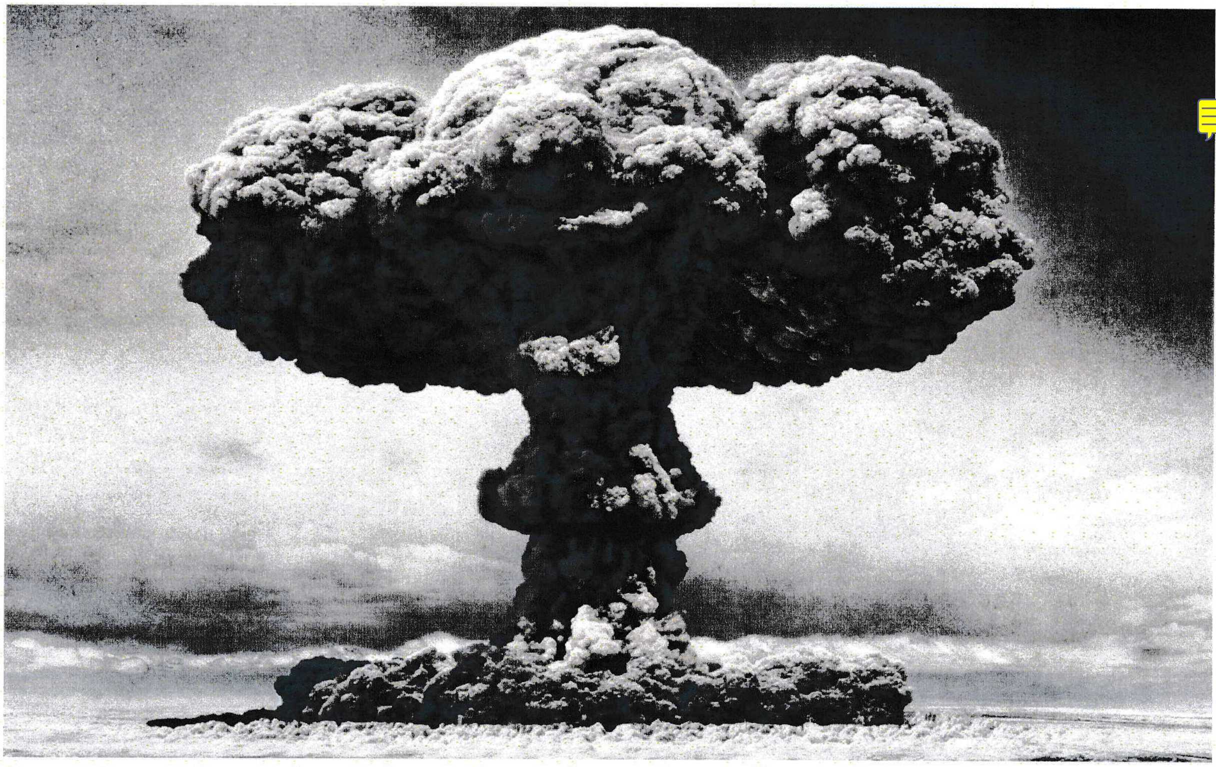
A nuclear disaster can devastate the environment around it, damaging the wildlife in the area, and also if the radiation is not controlled, rendering the area around uninhabitable for hundreds of years to come. This is another reason for the extreme importance of the reliability and redundancy behind nuclear power plants.

The general idea of people living near nuclear power plants is anxiety, and nuclear disasters don't help this matter. If there are too many accidents, the citizens living near nuclear power plants won't want them anymore, so the government will have to find new sources of power, which costs money. Therefore, they want to keep people happy, by keeping them safe with a reliable nuclear power plant with plenty of redundancies.

2. Explain the importance of reliability in the development of the ....

Reliability of nuclear power generators is extremely important, for a number of reasons. One is that over 20% of the US alone relies on nuclear power, but even more importantly is safety considerations. Most people are aware of the devastation nuclear disasters can create, and scientist have known this since the creation of the nuclear bomb in 1945. So when nuclear power was being created, reliability was of paramount importance, for safety reasons primarily. A nuclear disaster could be potentially very dangerous if not dealt with, so nuclear plants are designed to run for extended periods, to produce enough power, but also run safely, to avoid any deaths or damages.

Economic considerations are very important in the reliability of nuclear power plants too, since decommissioning a nuclear plant can cost anywhere between $300 million and $400 million US dollars. This is obviously very expensive, so on an economic standpoint, it is very important that nuclear power plants work well, and does this consistently. Heres what might happen if a reactor goes into meltdown...:



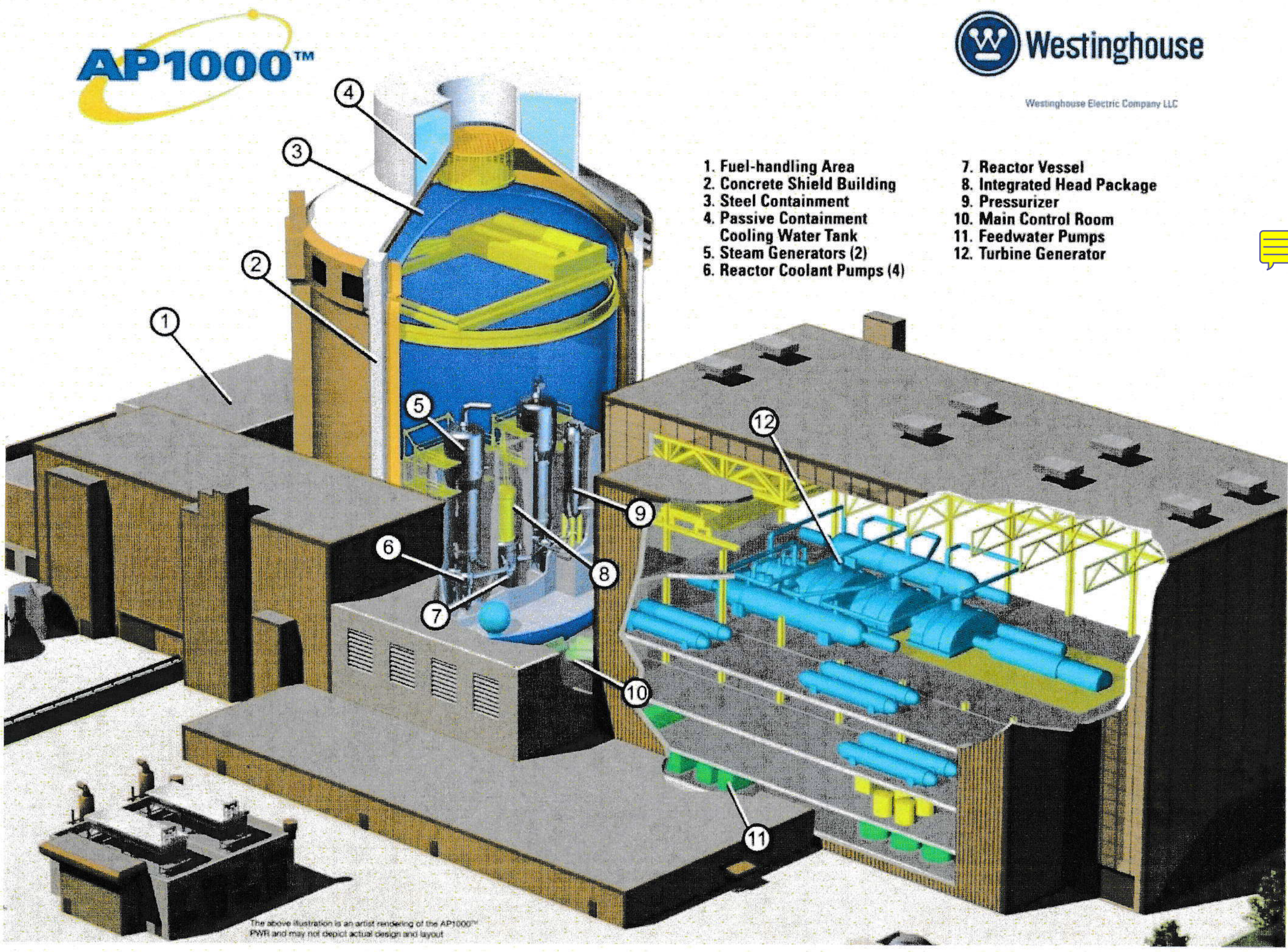
3. Describe how redundancy was applied and reliability was addressed in the ....

According to the nuclear safety website, the steps taken to ensure that nuclear power plants are safe and reliable include:

- High quality design and construction
- Proper equipment to ensure safety of people and avoiding problems
- Extensive monitoring of the systems and constant tests of the systems to detect issues
- "redundant and diverse" systems to deal with any damages and avoid catastrophe
- If catastrophe where to occur, containment systems have been put in place

To elaborate on these points, there is a large number of safety features that make a nuclear power plant reliable, through redundant backup systems. For example, the reactor protection system (RPS) is designed to immediately stop the reactor by stopping the chain reaction, thus eliminating the source of the heat. Another feature is where neuron-absorbing liquid is injected into the reactor, thus slowing the reaction down dramatically. There are over 5 coolant systems, all work together to keep the reaction under control and cool. For example, the high pressure coolant injection system (HPCI) pumps liquid and increases the pressure which also helps cool down the reaction. So these are some examples of systems that can help avert a potentially devastating disaster.

If a disaster where to actually occur, despite all of the safety procedures that can stop the reaction before it gets out of control, there are many of redundancies that are designed to contain the reaction so it can be controlled. The first feature is called fuel cladding. Its purpose is to prevent the fuel from corrosion, which would spread radiation around the reactor. The second security measure is the reactor vessel. This is designed to contain the majority of the radiation, as it can withstand high pressures. The third safety measure is primary containment. This is usually a large sheet of metal and concrete which contains the reactor vessel. This is also designed to withstand high pressures. After this there are 2 other safety features, secondary containment and core catching. Both are fairly similar to the other safety features, as they are both designed to contain the radiation and can withstand high pressures. So, with all these safety features, it is uncommon that radiation will actually escape the reactor. All these features apply reliability and redundancy to the reactor. Below is a photo of a nuclear reactor:



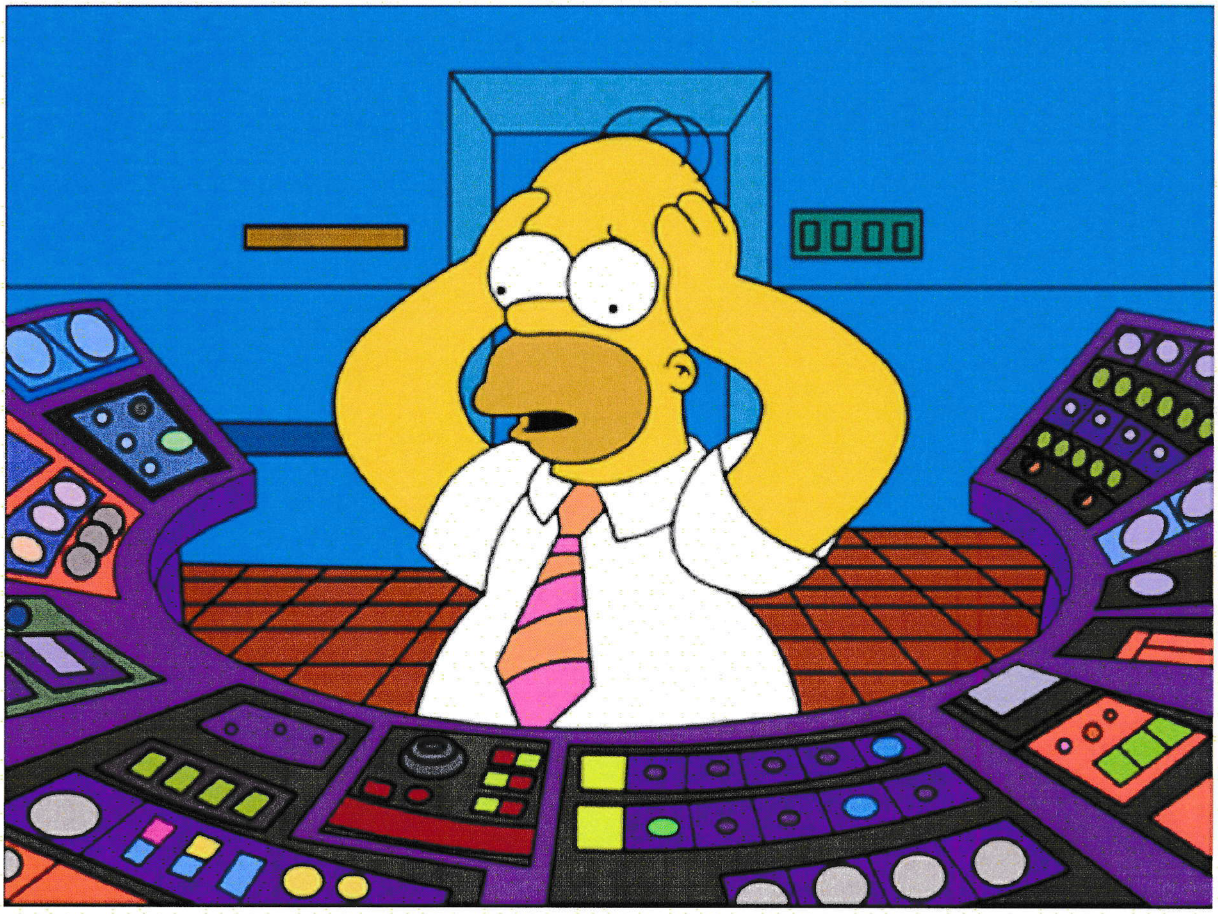
NZQA...

4. Discussing how redundancy and reliability implications influenced design and maintenance decision making in the development of a ....

When designing nuclear reactors, the engineers had to bear in mind many things. For example, the implications of physical maintenance by service personnel, the possibilities of including self-maintenance, and extra reliability and redundancies built into the system to avoid any maintenance altogether.

Physical maintenance on a nuclear reactor is very tricky. When the reactor is running, it is way too hot to do any sort of maintenance, so for maintenance to happen, the reactor has to turn off. This alone is very expensive, so they try to avoid physical maintenance as much as possible, but I'll talk about this later. Physical maintenance is done about every 2 years, and it can stay off for 30 to 60 days, depending on how much maintenance is needed. General maintenance that is undertaken can include refueling the reactor by replacing the fuel rods. This is done by removing the top of the reactor, removing the fuel rods carefully from the core, then replacing them. Some other maintenance can include replacing the steam generator, or checking the transformers about every 5 years. All of this is quite expensive, but it is done to avoid a meltdown, which would be even more expensive. If a meltdown where to occur, engineers have designed the reactor very carefully to prevent any damage done.

To prevent the release of radiation in the event of a meltdown, engineers have designed something called the "defense in depth". This basically means that the more redundancies you have, the better chance of containment. In this case, a nuclear reactor has 4 redundancies. First, the fuel ceramic, second the metal fuel cladding tubes, third the reactor vessel and the coolant, and finally, the containment building, the last line of defense. The containment building is a dome shaped structure usually built with concrete and reinforced with steel or lead, and can withstand pressures of between 40 to 80 psi. It is in a dome shape, because that shape can withstand a greater force. If you look at an egg for example, the top of the egg is much harder to break than the sides, so the reactor is designed to divert the majority of the pressure to the dome part of the containment building, which will give the containment building a better chance of containing the meltdown.



So, as you can see, the people who engineered nuclear reactors have over the years refined and improved the reliability and redundancies of reactors, so effectively that nuclear reactors have become very safe. They use very cleverly designed systems to control a meltdown if it were to happen, and even better systems to stop one from happening from altogether. And if one were to happen, no doubt we will learn from the mistake, and make reactors even safer in the future.