Eric Altenburg HST-415 November 15, 2020

Week 11: Nuclear Power — Video

Part 1

Nuclear Reactors

1. Basic Reactor Theory
   - Slow nuclear reaction
   - You can make reactors that are completely safe
     - Variable safety
   - Uses U-238 in it (lowers the probability and stops neutrons)
   - Moderator: bounces the neutrons around to make it likely to hit U-235
   - Control rod: absorbs neutrons so that it doesn't fission too fast
2. Reactor engineering example: TRIGA
   - ***Was this TRIGA reactor a part of the NPT treaty?***
   - As it gets hotter, it reduces the neutron probability of hitting fuel

The road to peaceful nuclear power

1. Postwar reactor research
   - In 1940 reactor research taken over by AEC
   - Mainly used for research and plutonium production
2. Atoms for peace
   - Promote peaceful international uses of atomic energy
   - Declassify peaceful tech, reactor work, basic science, some enrichment info, etc.
3. Atomic energy act 1954
   - Changes:
     - US can share info to allies
     - US can share reactor info with private industry
   - During this time, push for private reactor research
4. Naval Reactors
   - Hyman G. Rickover
     - AEC and Navy
   - Makes submarine nuclear reactor
5. Types of reactors
   - ***Does the pool of water get emptied in the BWR?***
   - ***Why do the cool down towers have that iconic shape to them?***
6. Nuclear concerns by the 1970s
   - Concerns about accidents:
     - loss of coolant
     - meltdown
     - risk = (probability of accident) $*$ (expected consequences)
     - high powered reactors have low prob of accident, but high consequences = "high risk" technology
   - Concerns about waste:
     - spent fuel very radioactive for a few decades—fission products
     - less radioactive for thousands of years
     - how to guarantee a structure will survive for millennium?
     - reprocessing possible—but expensive and raises security issues
   - Concerns about economics:
     - high capital costs
       $*$ licensing, development, maintenance
       $*$ expensive anywhere, but just US, but US legal system makes very expensive
       $*$ takes a long time to pay for itself—must run plant for 30-40 years

  - never any "organic demand" for nuclear power (maybe today, with concern about environment/climate, there is)

Part 2

Three Mile Island

1. TMI Nuclear generating Station
   - Why have a nuclear reactor that costs hundreds of millions and takes a decade to run when you can make a natural gas generator that's cheaper and easier to run which will turn a profit sooner?
   - Largely a failure in engineering
     - PORV fails and opens fully, light in control room doesn't show this, just shows that it was attempted to close
   - The workers have degrees so it wasn't stupidity that failed
   - General emergency is declared but no one knows who is in charge when this happens
   - Partial core meltdown
2. Immediate results
   - No long-term health consequences at TMI
   - No one was injured
   - Focus on change with the "human factor engineering" in plant design
     - i.e. working at 4 am, alarm blaring so they couldn't think
3. The China Syndrome
   - By 1979, anti-nuclear power movement becomes mainstream
     - TMI doesn't help
   - *The China Syndrome* released 12 days prior to TMI accident so it is tied with it
4. Consequences for the reactor industry
   - On top of the initial capital, there is now lawsuits that the reactor companies have to pay for

Chernobyl

1. Nuclear power in the USSR
   - ***What did the HBO series Chernobyl get wrong?***
   - 2 main reactor design: VVER (PWR), and RBMK
   - RBMK is quick to assemble, cheap, easy to build locally, and can convert to a PU-239 production if desired
2. RBMK Reactor
   - Graphite moderator and water coolant
     - If water stops, then there is still a moderator in it
     - Unlike having water acting as both
3. Chernobyl
   - RBMK had a feedback loop that made it hotter and hotter with no containment vessel
   - Soviet gov't. slow to react, cities not evacuated
   - Vast areas of Ukraine and Belarus rendered essentially uninhabitable
   - Who or what is to blame?
   - ***Was there a similar anti-nuclear movement? Same for Japan.***

Fukushima

1. Nuclear Power in Japan
   - Have PWR and BWR
   - Japan is one of the most seismically active areas of the planet with little land area to spare
   - Tectonic theory really picked up after nuclear power era
     - Most reactors probably not in a good area
2. Fukushima Daiichi
   - 6 BWR reactors

- partial meltdowns in 1, 2, 3
- Hydrogen bubble build up so units exploded and exposed other units' reactor rods

Nuclear Waste

1. Nuclear Waste
   - Seen as an issue for the future
   - US liked the idea about just burying it in a dry cool place
     - Operation salt vault
   - Deep ocean disposal
   - US currently doesn't have centralized disposal site
     - Now they place waste near the respective reactor facilities
   - How to communicate danger to people 10,000 years in the future?
     - i.e. if future civilization has lost all knowledge

Questions about nuclear power

1. Big, difficult questions
   - Is nuclear a "green" tech for a world worried about climate change?
   - 50/50 favor/in-favor of nuclear power