University of Pittsburgh

ME/ENGR 2100 Fundamentals of Nuclear Engineering

Fission Reactor Basics:

PWR and BWR Cores

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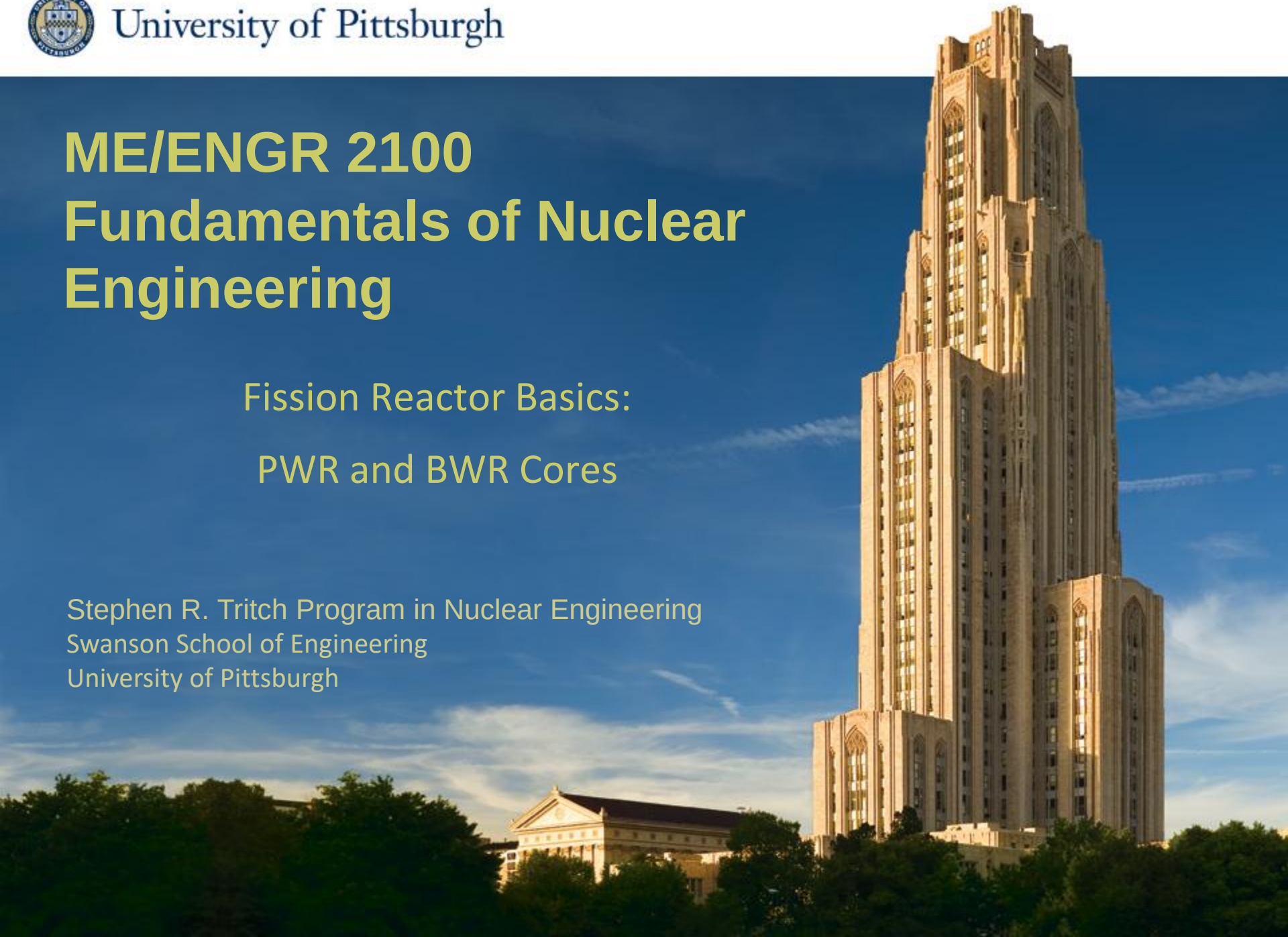


Relevant Reading Assignments

- Sections 6.5 to 6.8 of "*Introduction to Nuclear Engineering*" by Lamarsh and Baratta, 3rd Edition.
- Chapter 3 of "*Nuclear Reactor Analysis*" by Duderstadt and Hamilton
- Page 100-120 of "*Nuclear Engineering: Theory and Technology of Commercial Nuclear Power*" by Knief, 2nd Edition.

Relevant Reading Assignments

- "Secrecy, simultaneous discovery, and the theory of nuclear reactors" by Spencer Weart. American Journal of Physics, Vol. 45(11). November 1977

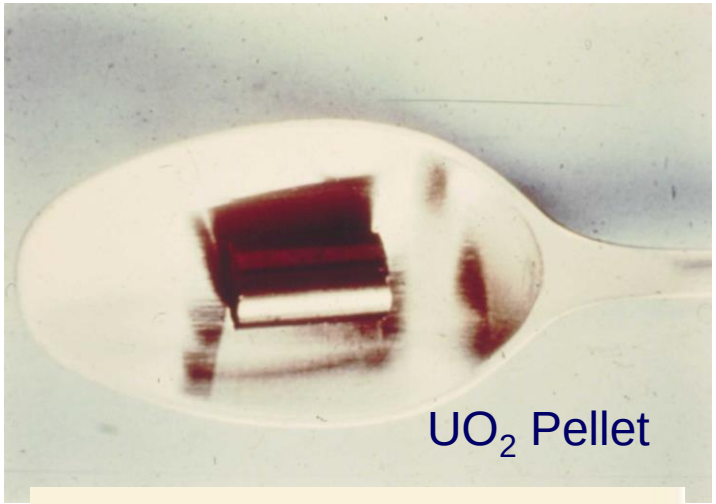
Learning Objectives

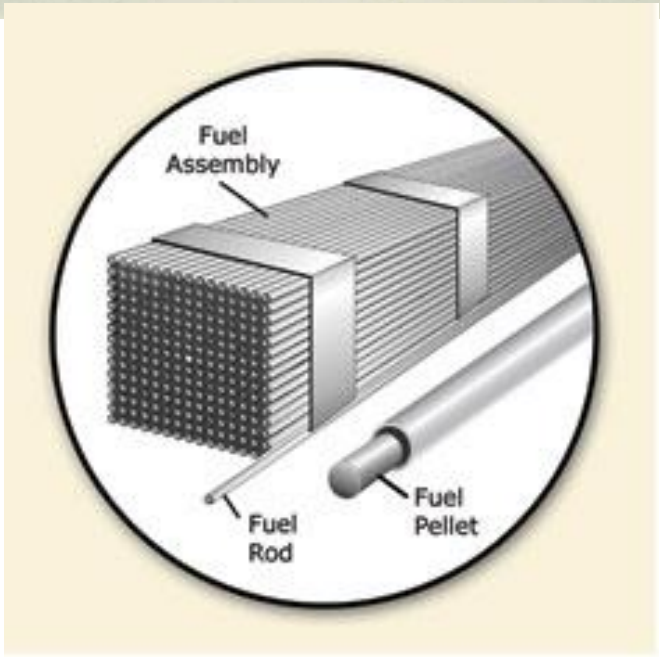
- Describe PWR and BWR fuel assemblies and some of the differences between them

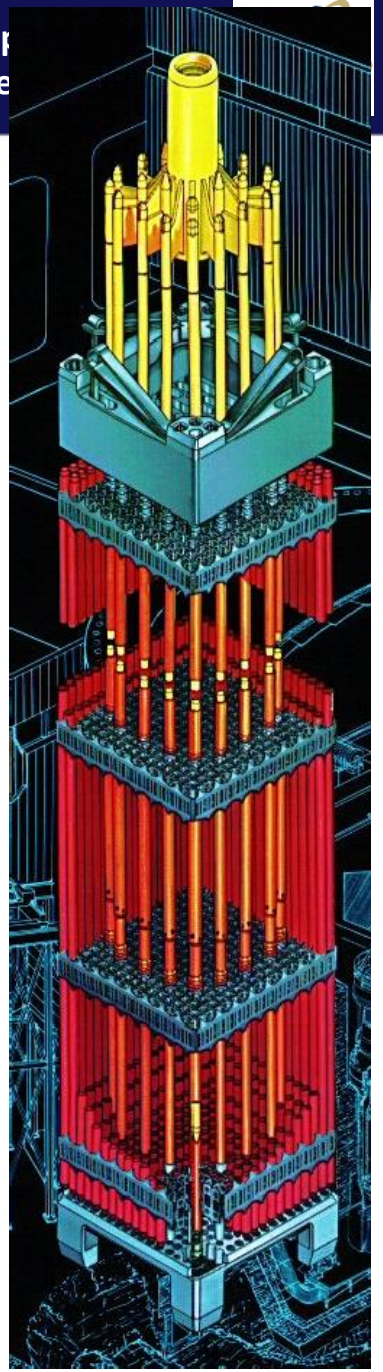
PWR Reactor Designs

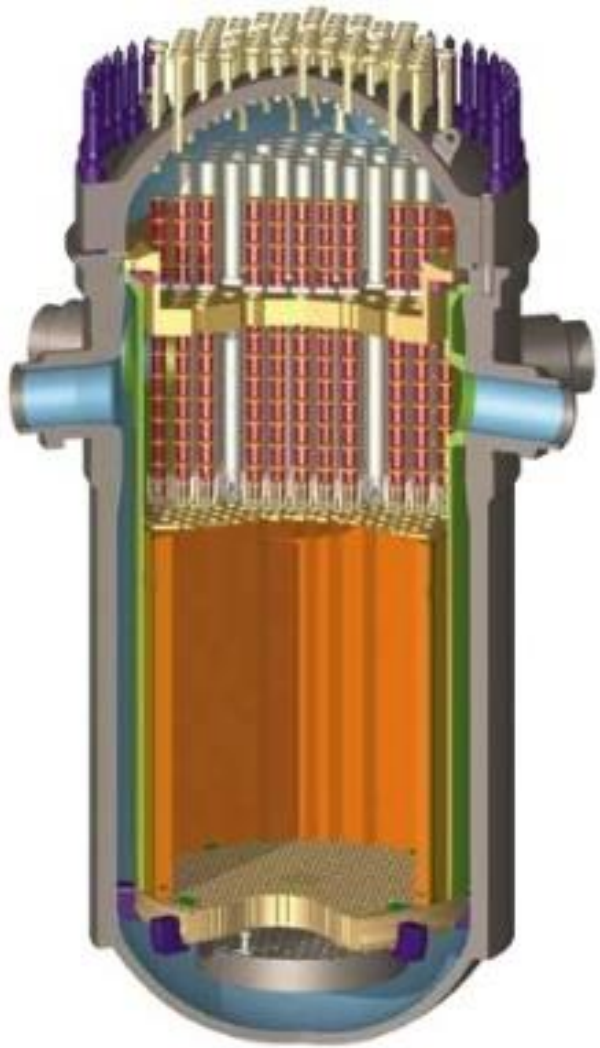
- Modern commercial light-water reactor designs still follow this heterogeneous (lumped fuel) design:
  - Fissile Uranium fuel in small ceramic pellets.
    - Cylindrical: 3/8” diameter × 1/2” height
  - Pellets stacked axially into fuel elements roughly 12 feet high
    - ~288 pellets per element
  - Fuel elements are arranged into square fuel assemblies
    - 14 × 14 or 17 × 17 elements per assembly
    - Lattice spacing is determined by moderation studies like shown on the previous slide.
  - Fuel assemblies are arranged in a roughly cylindrical core shape
    - ~145 assemblies per core

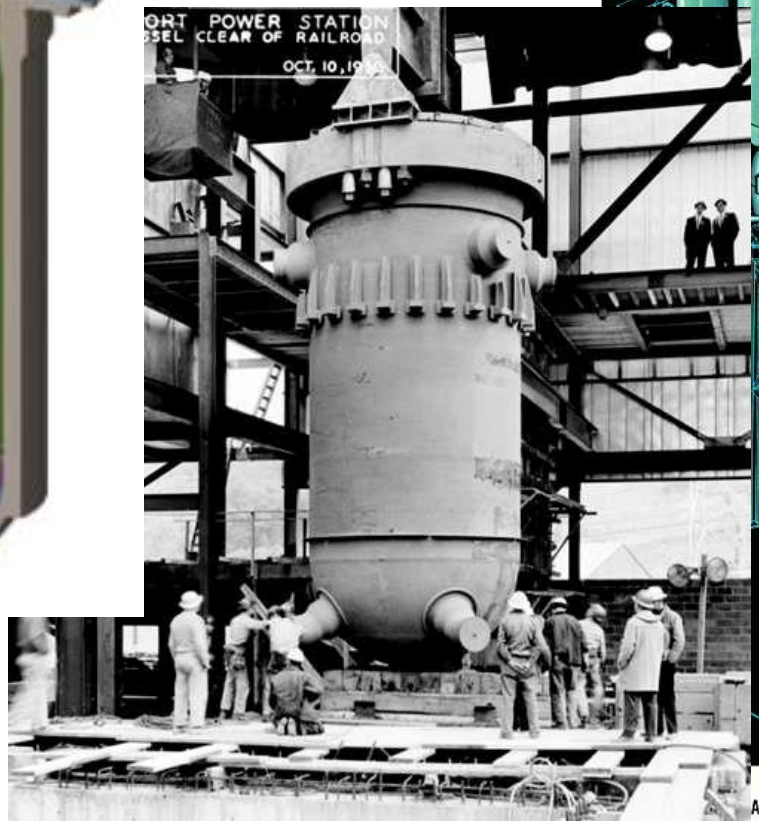
Reactor Fuel

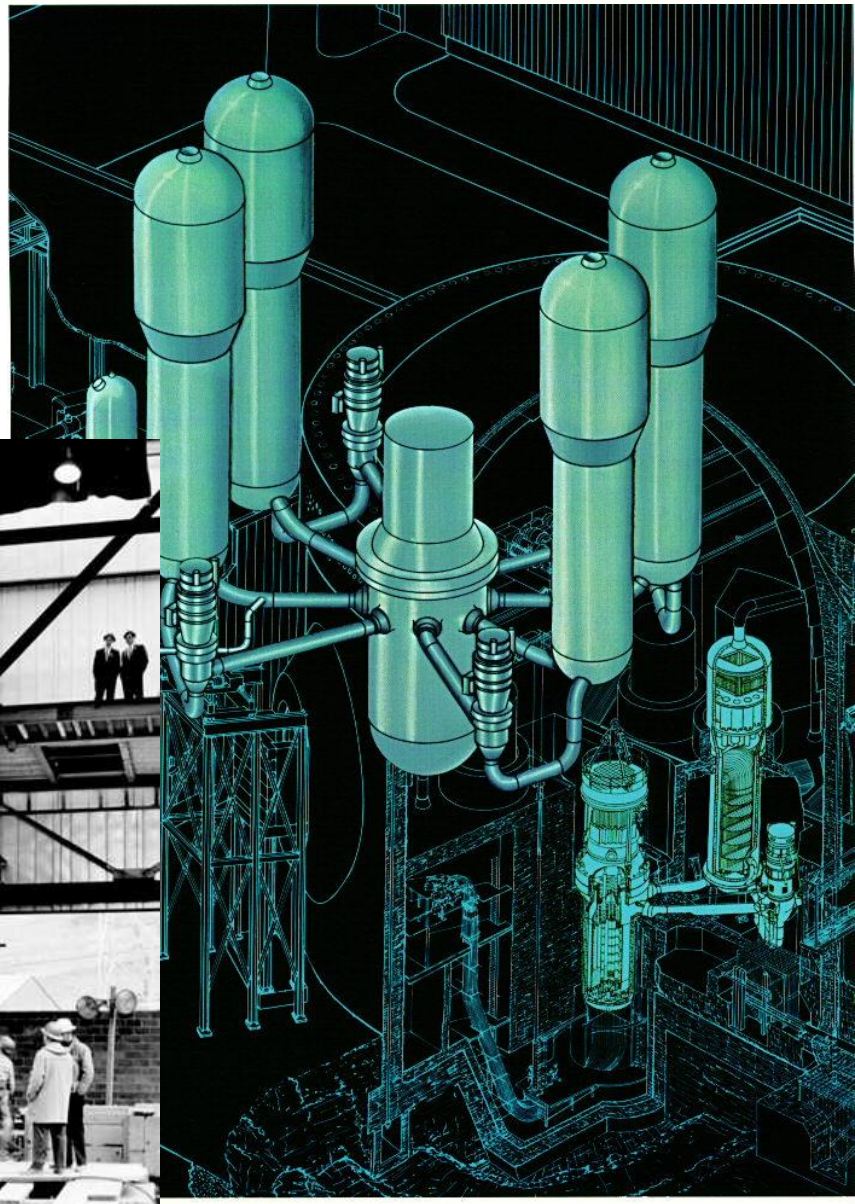






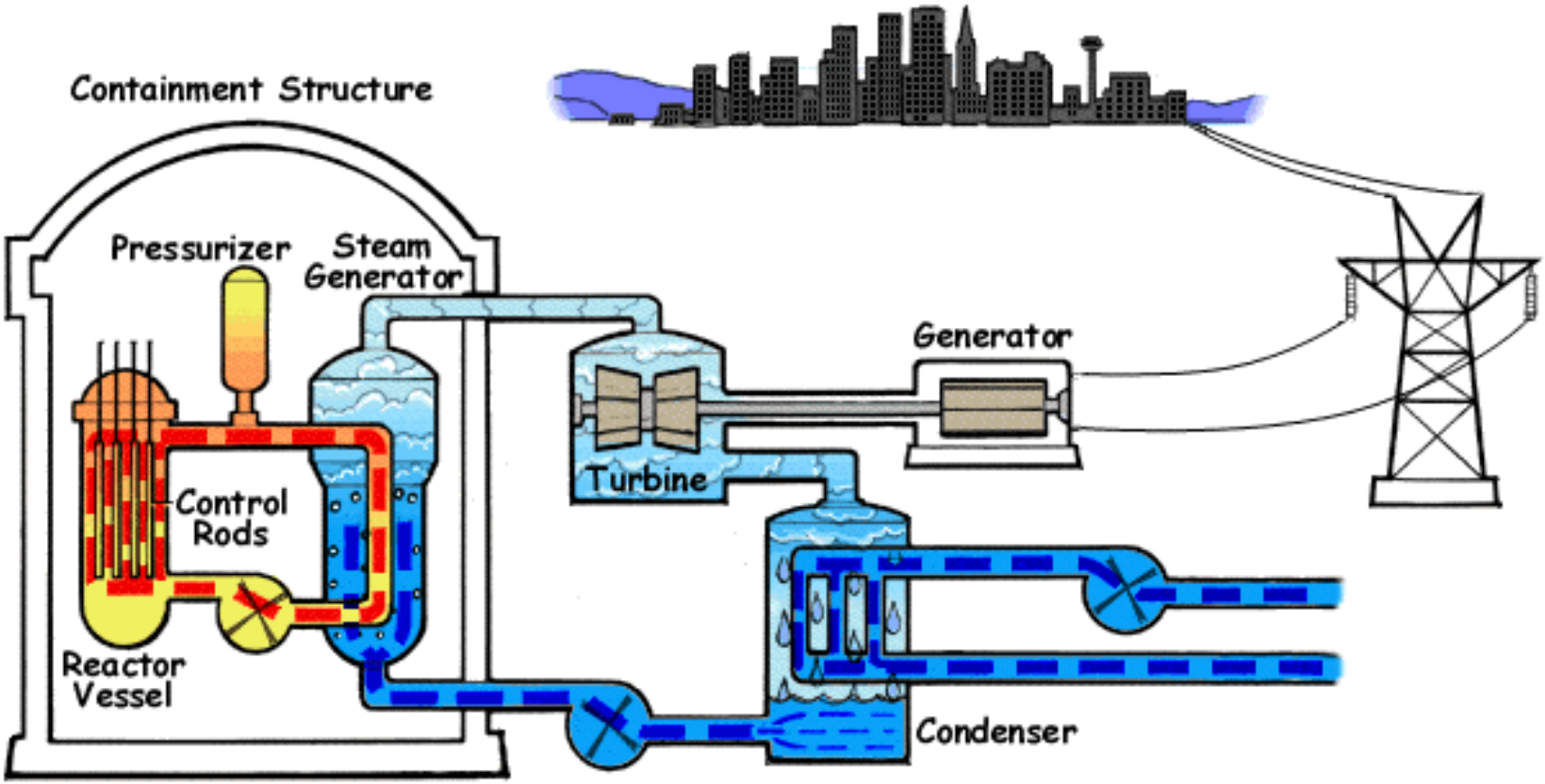






AR STEAM SUPPLY SYSTEM

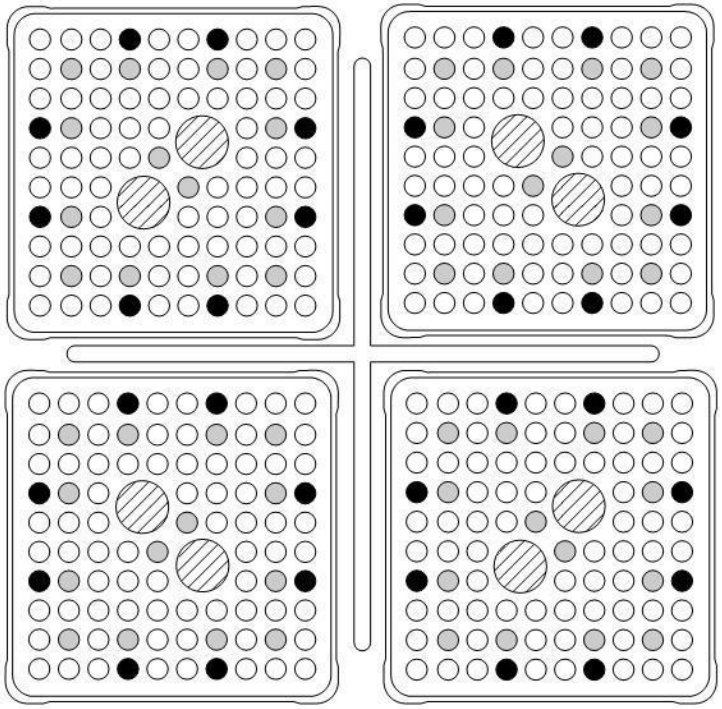
Pressurized Water Reactor



BWR Reactor Designs

- BWR fuel is similar to PWR fuel
  - Similar heights and pellet dimensions
- There are also many differences
  - BWR bundles are generally “canned” by a thin tube which surrounds each bundle
  - BWR bundles contain far fewer fuel rods (10x10) resulting in up to 800 assemblies in a BWR core
  - BWR bundles contain large central water rods and some designs contain partial length rods
  - The control rods in a BWR come between bundles and so there are no rod positions within an assembly

Reactor Fuel



FUEL ROD
PART LENGTH ROD
TIE ROD
WATER ROD

BWR/6 FUEL ASSEMBLIES & CONTROL ROD MODULE

1.TOP FUEL GUIDE
2.CHANNEL FASTENER
3.UPPER TIE PLATE
4.EXPANSION SPRING
5.LOCKING TAB
6.CHANNEL
7.CONTROL ROD
8.FUEL ROD
9.SPACER
10.CORE PLATE ASSEMBLY
11.LOWER TIE PLATE
12.FUEL SUPPORT PIECE
13.FUEL PELLETS
14.END PLUG
15.CHANNEL SPACER
16.PLENUM SPRING

GENERAL ELECTRIC