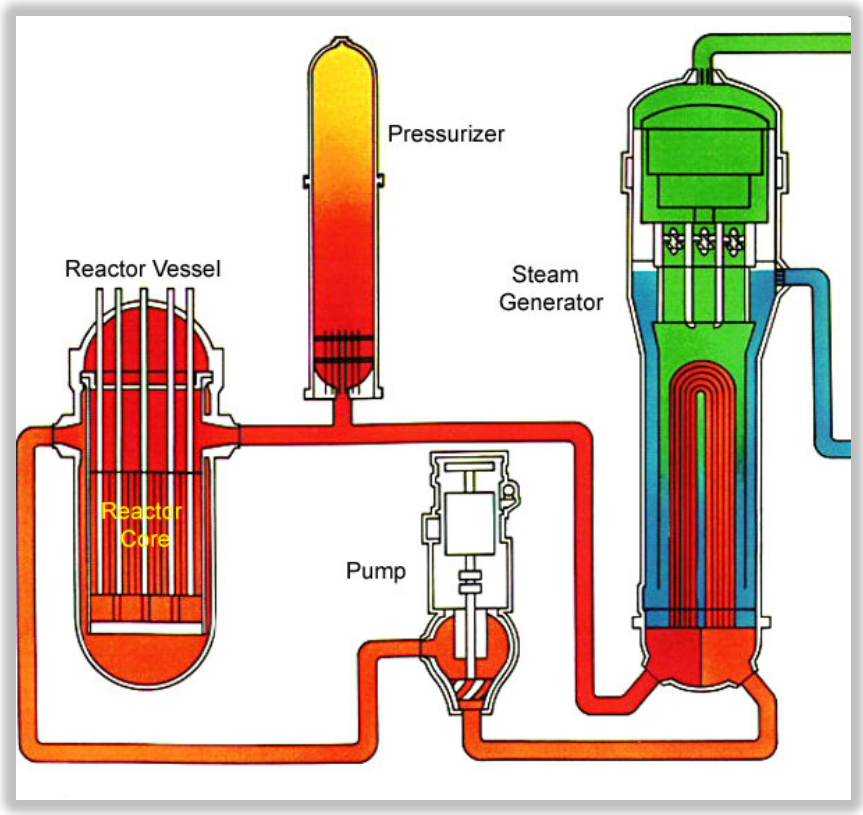
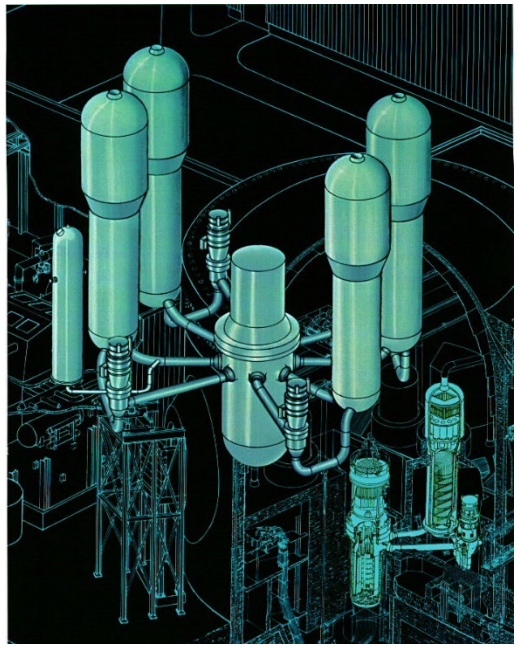
# Steam Generator Tube Rupture

Part of the RASCAL Instructor-led Training

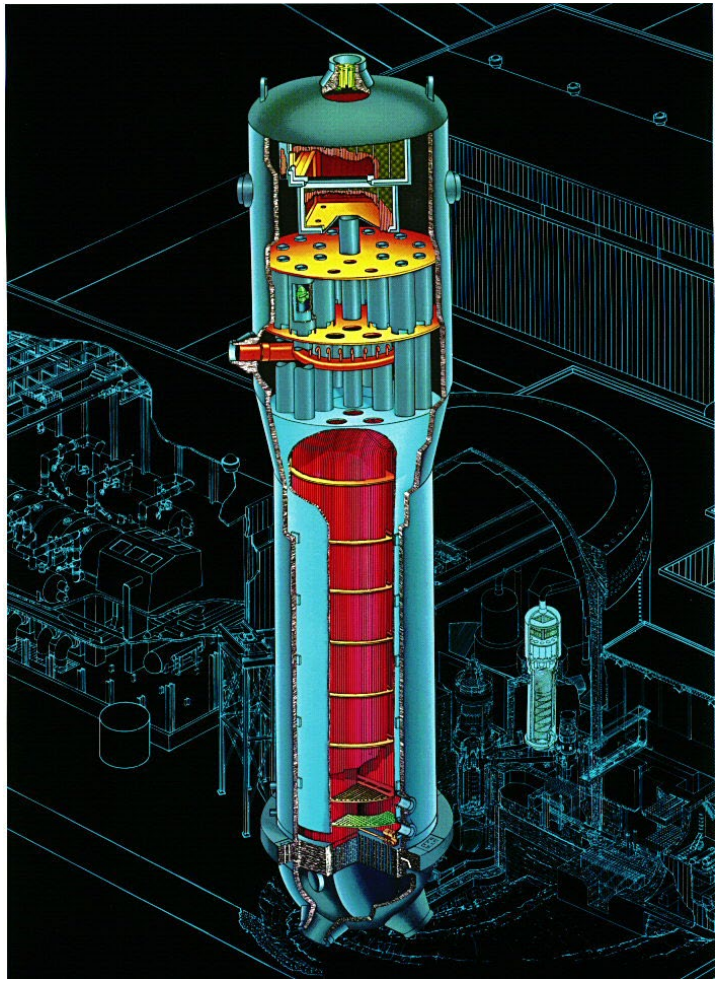
# THE STEAM GENERATOR IN THE PWR IS THE SITE OF HEAT EXCHANGE BETWEEN THE PRIMARY SIDE (CORE) AND THE SECONDARY SIDE (TURBINES).




There are usually 2 or 4 steam generators in PWRs.

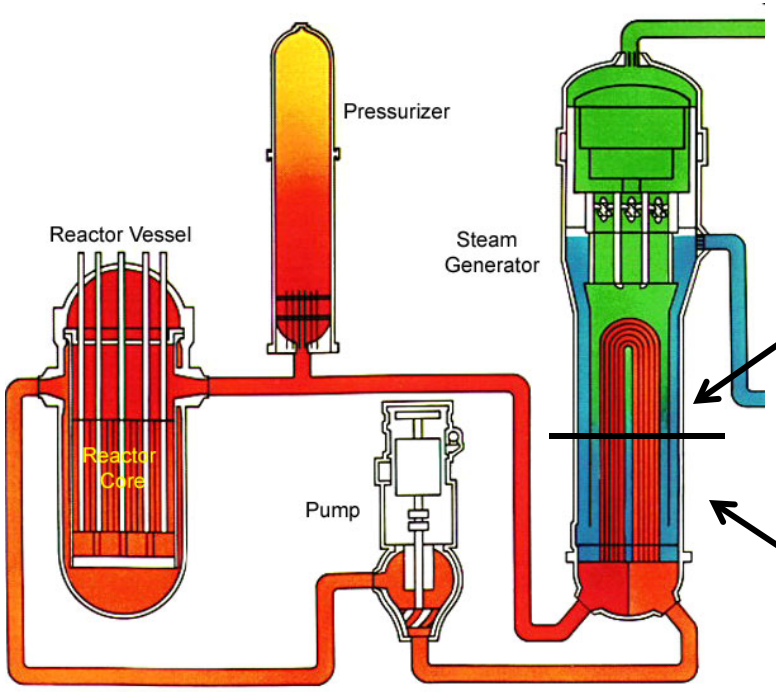


# There are two steam generator types: U-tube and once-through.



Each steam generator contains 3,000 – 16,000 tubes; each about 0.75 inches in diameter.

# A STEAM GENERATOR TUBE RUPTURE (SGTR) ALLOWS PRIMARY SYSTEM COOLANT TO ESCAPE RAPIDLY INTO THE SECONDARY SYSTEM.




Leak above the water – most nuclides available for release; 50% of non-nobles escape.

Leak below the water – nuclides scrubbed and unavailable for release; 2% of non-nobles escape.

# THE SGTR LEAK RATE IS DETERMINED BY THE RATE OF PRIMARY COOLANT LOSS AND LOSS OF STEAM FROM THE GENERATOR.

Estimate the primary coolant loss from the makeup flow rate.

Leave steaming rate at default unless better information is available.

# SGTR RELEASES CAN BE THROUGH SAFETY RELIEF VALVES OR THE CONDENSER OFF-GAS EXHAUST.

Safety relief valve is an unfiltered pathway.

Condenser off-gas exhaust – only 5% of non-noble gases released.

# Steam Generator Tube Rupture - Scenario

The St. Lucie, Unit 1, Nuclear Power Plant experienced a sudden drop in primary system pressure and a sudden rise in secondary pressure at 00:36. The resulting drop in primary system pressure caused the reactor to automatically shutdown at the same time.

# Steam Generator Tube Ruptures in RASCAL

- RASCAL treats it as a release pathway; in reality it is also an initiating event
- All reactor system pipe breaks can be modeled 2 ways depending on volume of coolant leak:
  - LOCA (large or unrecoverable break, core melt)
  - Coolant Release (smaller break, no core melt)

- For coolant release models (simple SGTRs with no degrading conditions):
  - Database has information about nuclides that would be in normal coolant
  - Coolant spiking

# Steam Generator Tube Rupture - Scenario

The control room operators assume that a steam generator tube rupture (SGTR) had occurred and estimate that the makeup flow (including safety injection) to be about 500 gpm.

The increase in steam generator pressure caused the high-pressure safety relief valves to open for 4 minutes, but subsequently the increased steam generator pressure is released through the condenser off-gas exhaust.

# Steam Generator Tube Rupture - Scenario

The control room operators have indications to assume that the SGTR break is above the water line (worst case) and that the steaming rate is at the default value.

The release point is the top of the turbine building, about 15 meters above ground.

# YOUR TURN TO USE RASCAL


St Lucie Unit 1 shutdown and start of coolant release at 00:36. Makeup flow to the reactor is about 500 gpm. The control room operators assume break is above the water line (worst case) and that the steaming rate is at the default value.

Releasing from top of the turbine building, about 15 meters above ground. Safety relief valves open for 4 minutes, but then released through condenser off-gas exhaust.

Do an assessment using *Standard Meteorology* dataset and ICRP 60/72. Determine the projected TED and Child Thyroid CED at 0.2 miles, assuming that a Protective Action couldn't be ordered until about 8:30am.

| | **Dose at 0.2 miles from the site** |
|---|---|
| **TED (rem)** | |
| **Child Thyroid CED (rem)** | |

# LET'S WALK THROUGH THE PROBLEM TOGETHER

# KNOWLEDGE CHECK


What projected max dose (TED) did you get at 0.2 miles?

- 4.8E-03 rem
- 2.4E-03 rem
- 3.6E-04 rem
- None of the above values

# Steam Generator Tube Rupture - Results

- Doses are low – coolant release; no core damage
- Generally the SG is isolated and any release is very small
- Improved fuel quality reduces spiking factor

| | Dose at 0.2 miles from the site |
|---|---|
| **TED (rem)** | 2.4E-03 |
| **Adult Thyroid CED (rem)** | *** |