

Equations used in Stephen R. Berggren's Apple Nuclear Power Plant Simulation

Kevin Riggle

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Or, *Nuclear Power Plant: The Board Game*.

Each turn represents a day in the life of a nuclear power plant.

1 Warning Thresholds

Notify the player when these thresholds are exceeded:

- Reactor overheats above 800°C .
- Heat Exchanger overheats above 500°C .
- Turbine output is low below 1000 kW.
- Turbine output overloads above 2000 kW.
- Cooling Tower overheats above 300°C .
- Emergency Cooling System coolant volume is low below 200 gal.
- Primary Cooling System coolant volume is low below 100 gal.
- Secondary Cooling System coolant volume is low below 100 gal.

Notify the player when these levels are met:

- The Reactor core is damaged when it has 4 or more points of damage.
- The Reactor core has melted down when it has 6 or more points of damage.
This ends the game in a loss.
- The Primary Cooling System is leaking when it has 5 or more points of damage.
- The Secondary Cooling System is leaking when it has 5 or more points of damage.

- The Emergency Cooling System is leaking when it has 3 or more points of damage.

Notify the player of these status conditions:

- The Primary Cooling System is broken. Report the coolant pump failure percentage as $10 \times$ the number of points of damage the system has, up to a maximum of 100% (10 or more points).
- The Secondary Cooling System is broken. Report the coolant pump failure percentage as $10 \times$ the number of points of damage the system has, up to a maximum of 100% (10 or more points).
- The Heat Exchanger is broken.
- The Turbine is broken.

2 Calculating Component Damage

2.1 Reactor overheated

Every turn when the Reactor is overheated (above 800°C), the reactor gains:

- 1 point of damage always
- 1 point if it is above 850°C
- 1 point if it is above 900°C
- 1 point if it is above 950°C

So the Reactor can gain up to 4 points of damage a turn.

Every turn when the Reactor is overheated the Primary Cooling System gains 1 point of damage.

Every turn when the Reactor is overheated the Emergency Cooling System gains 1 point of damage. The Emergency Coolant system gains 1 additional point of damage if the Reactor temperature is above 850°C .

2.2 Heat Exchanger overheated

Every turn when the Heat Exchanger is overheated:

- The Heat Exchanger gains 1 point of damage. The Heat Exchanger gains 1 additional point of damage if the Heat Exchanger is above 600°C .
- The Primary Cooling System gains 1 point of damage.
- The Secondary Cooling System gains 1 point of damage.

2.3 Turbine overloaded

Every turn when the Turbine is overloaded (output is above 2000 RPM):

- The Turbine gains 1 point of damage. The Turbine gains 1 additional point of damage if its output is above 2500 RPM.
- The Secondary Cooling System gains 1 point of damage.

2.4 Cooling Tower overheated

Every turn when the Cooling Tower is overheated (above 300°C), the Secondary Cooling System gains 1 point of damage.

2.5 Primary Cooling System coolant volume low

Every turn when the Primary Cooling System coolant volume is low (below 100 gal.), the Primary Cooling System gains 1 point of damage.

If the Primary Cooling System has 5 or more points of damage, the Primary Cooling System is leaking. Every turn reduce coolant volume by the number of points of damage the system has.

2.6 Secondary Cooling System coolant volume low

Every turn when the Secondary Cooling System coolant volume is low (below 100 gal.), the Secondary Cooling System gains 1 point of damage.

If the Secondary Cooling System has 5 or more points of damage, the Secondary Cooling System is leaking. Every turn reduce coolant volume by the number of points of damage the system has.

2.7 Emergency Cooling System damage

If the Emergency Cooling System has 3 or more points of damage, the Emergency Cooling System is leaking. Every turn reduce coolant volume by twice (2×) the number of points of damage the system has.