Fukushima Daiichi Update / United States Preparedness

March 22, 2011

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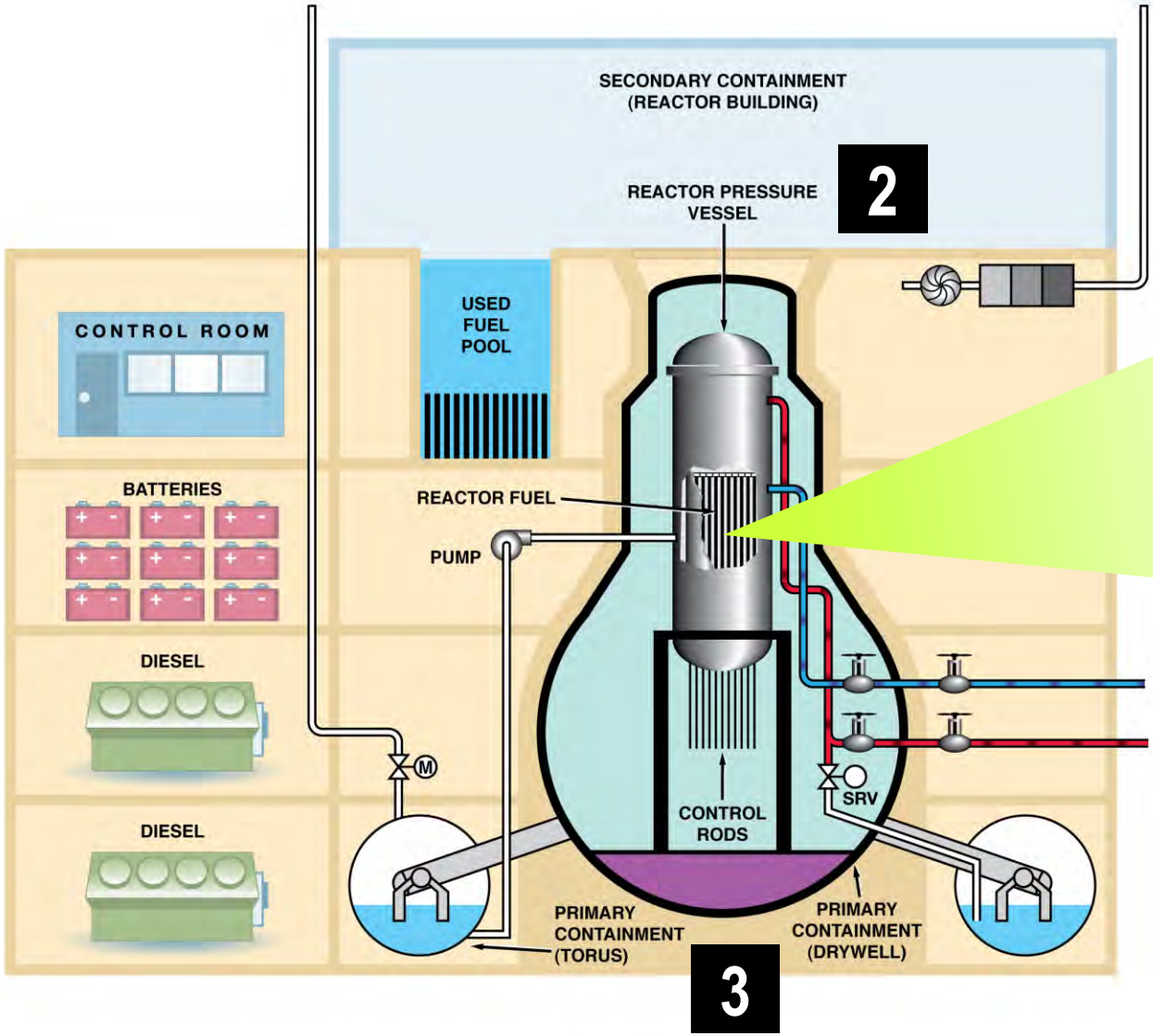
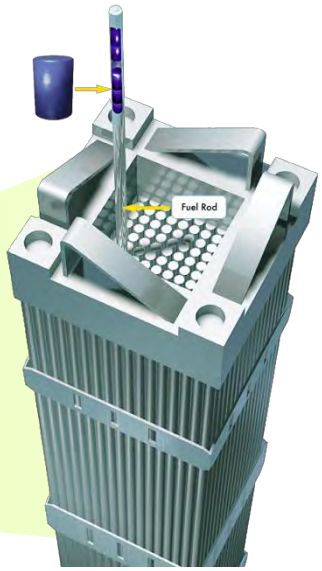
Six BWR units at the Fukushima Nuclear Station

- Units 1, 2, 3 in operation prior to event
- Units 4, 5, 6 in outage prior to event

Boiling Water Reactor – Three Barriers to Radiation Release

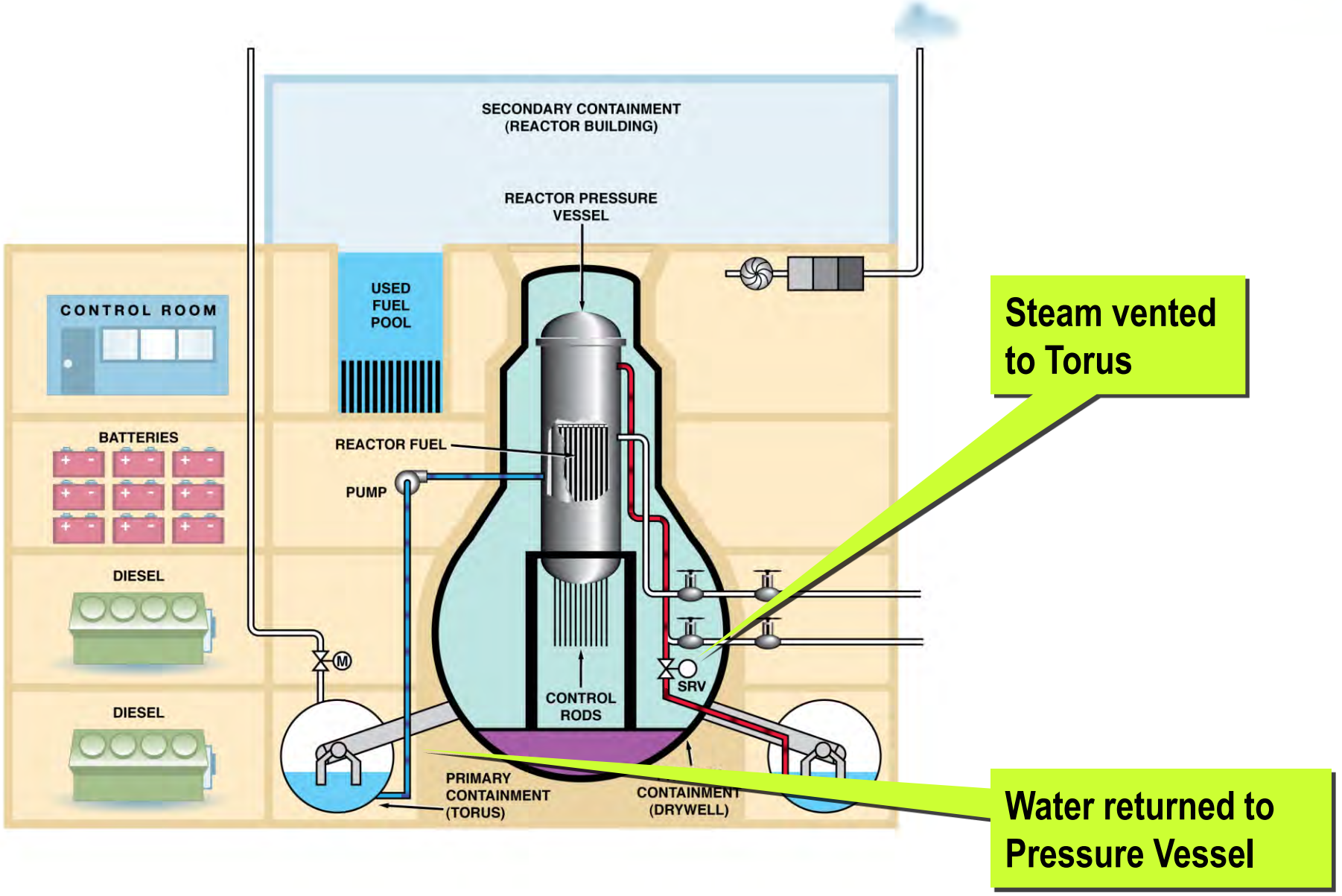




Fuel Cladding

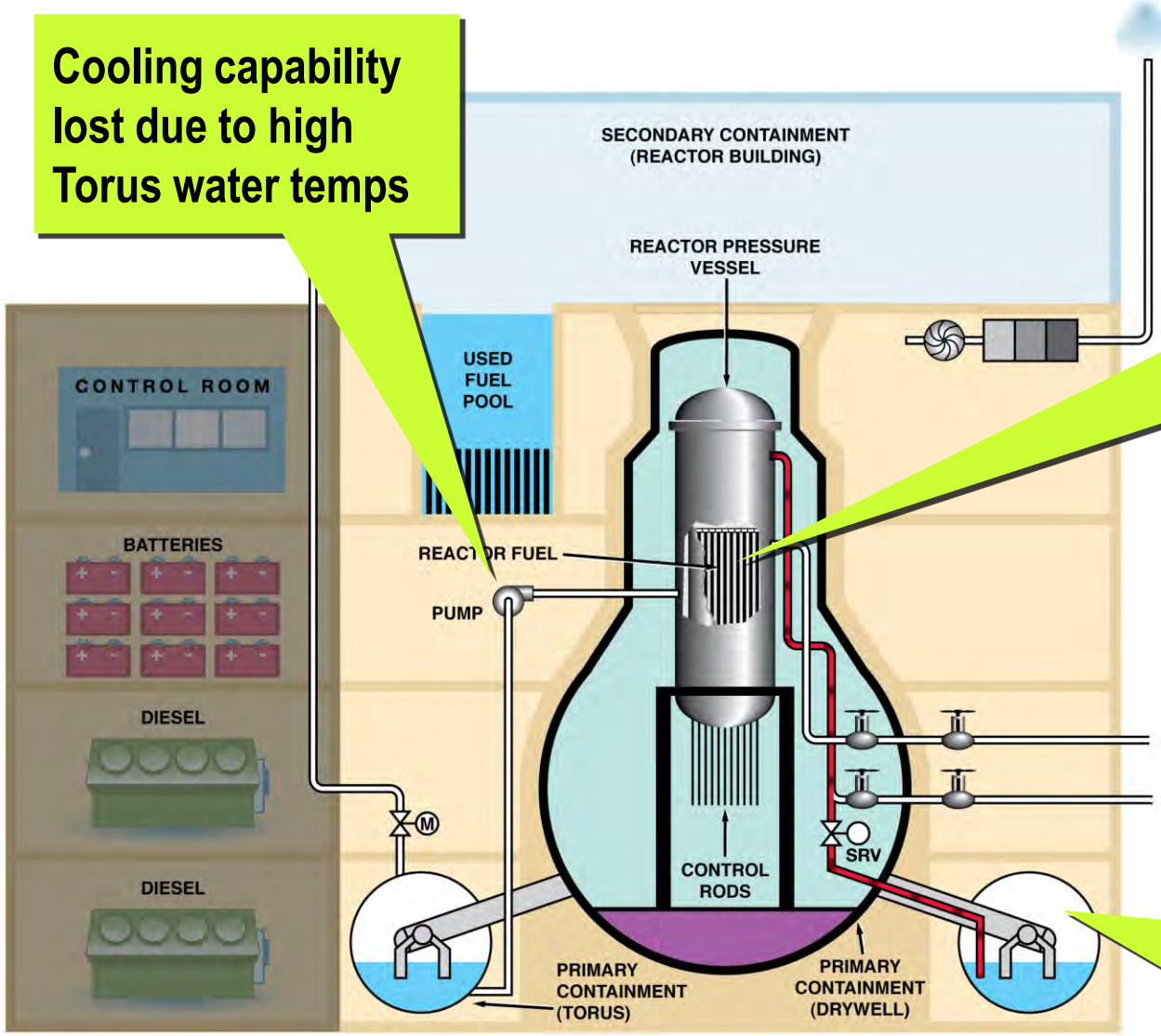
1

Japanese Plant Response following Earth Quake



Japanese Emergency Escalates following Tsunami

Cooling capability lost due to high Torus water temps



Fuel uncovered as steam vented to Torus

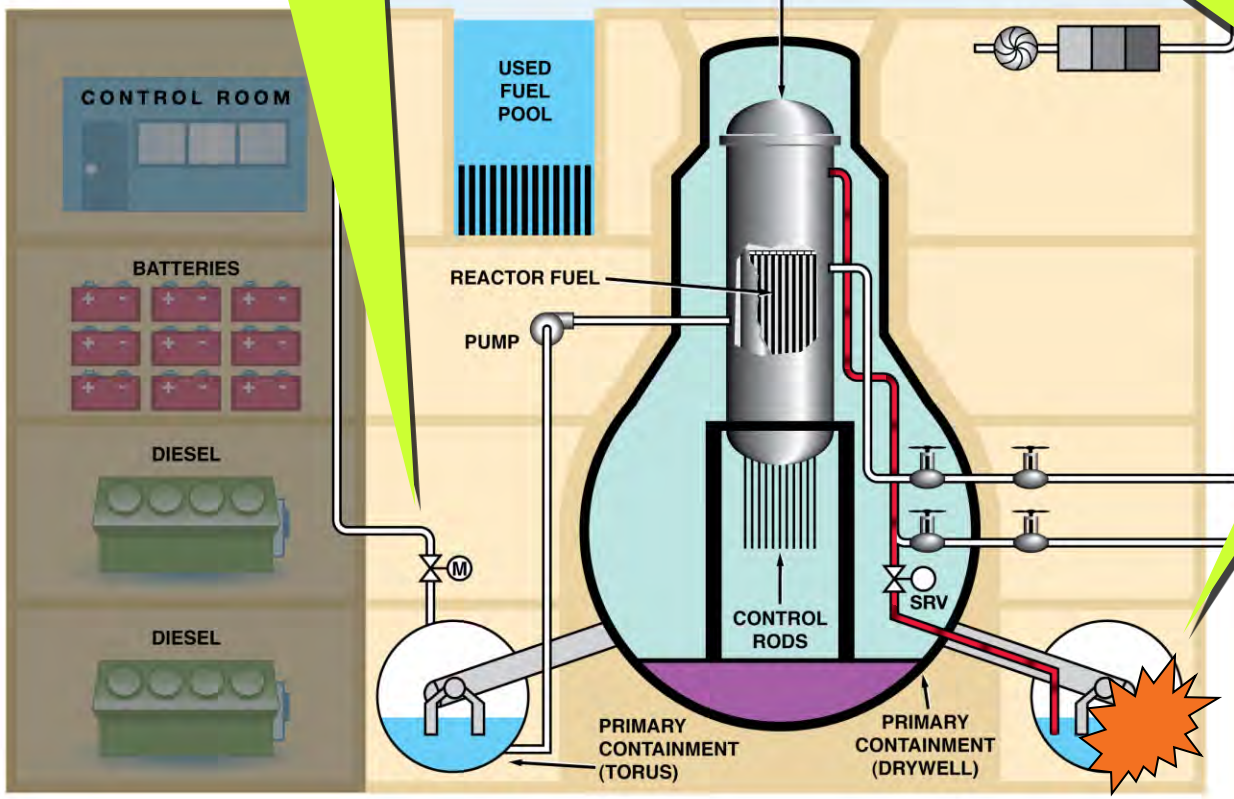
Hydrogen produced from fuel damage

Pressure builds up in containment

Hydrogen builds up in containment

Attempts to Vent Containment Result in Hydrogen Explosions

Operators attempt to vent containment



Hydrogen buildup explodes in Unit 1, 3 Reactor Building

Hydrogen buildup explodes in Unit 2 Torus

United States Plant Designs

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United States Plant Designs

Site – specific designed criteria developed for each site

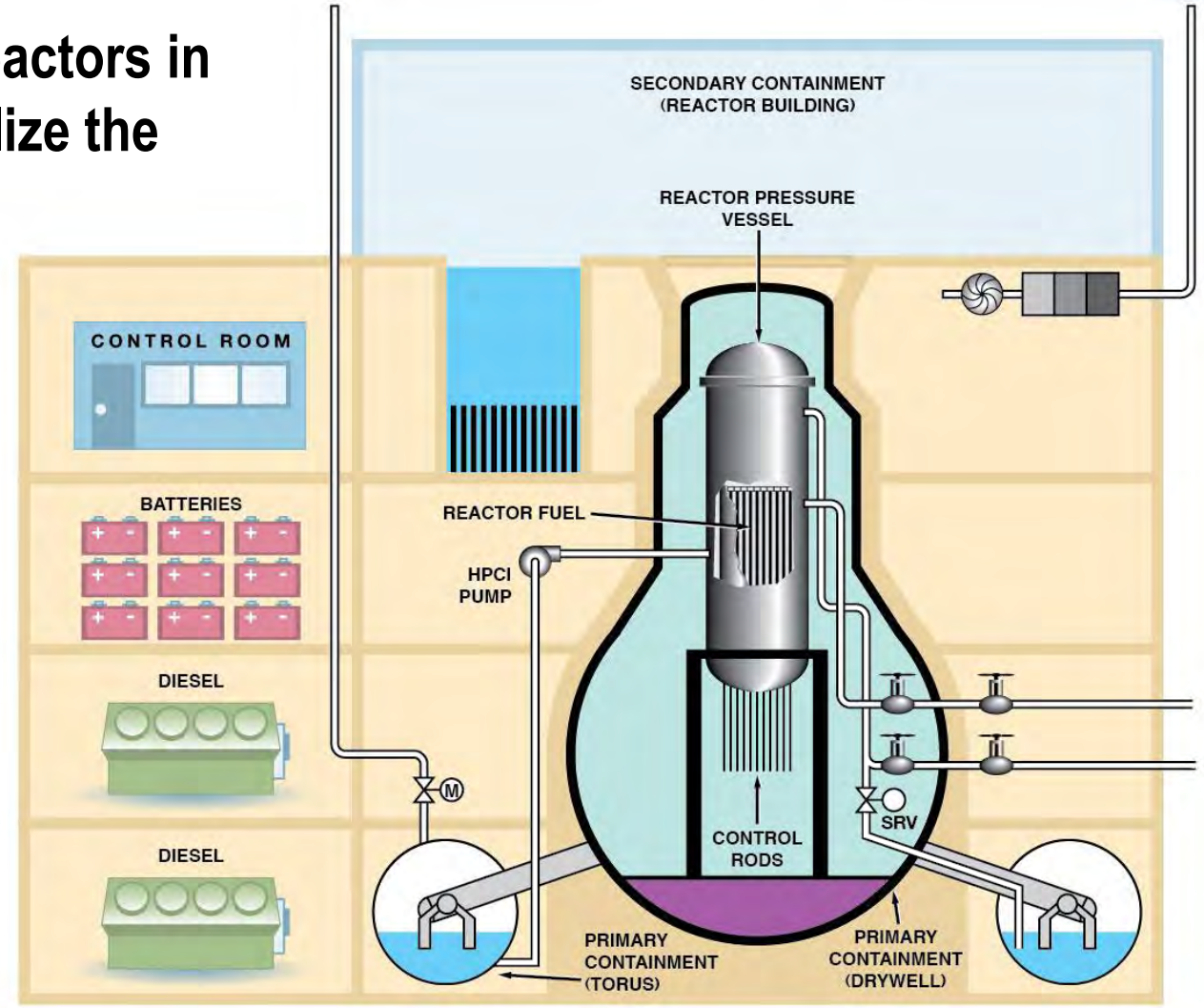
- Based on historical information with added conservatism (flood, hurricane, earthquake, etc)
- Based on geography

Plant designed to withstand severe events and maintain design basis

Plant modifications / upgrades implemented based on industry experience and strengthened regulation

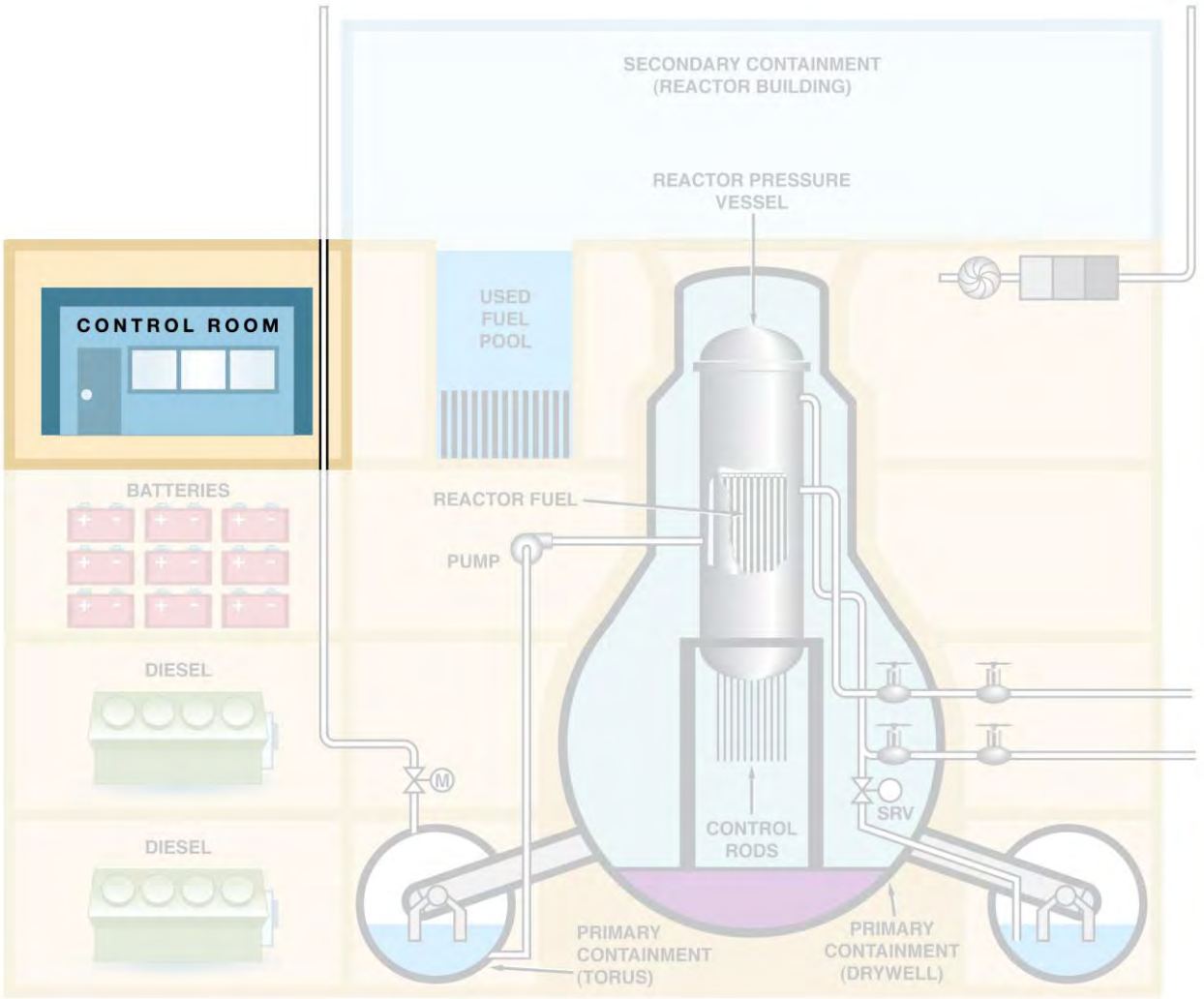
United States Design Improvements

23 Boiling Water Reactors in the United State utilize the Mark I Containment



United States Design Improvements

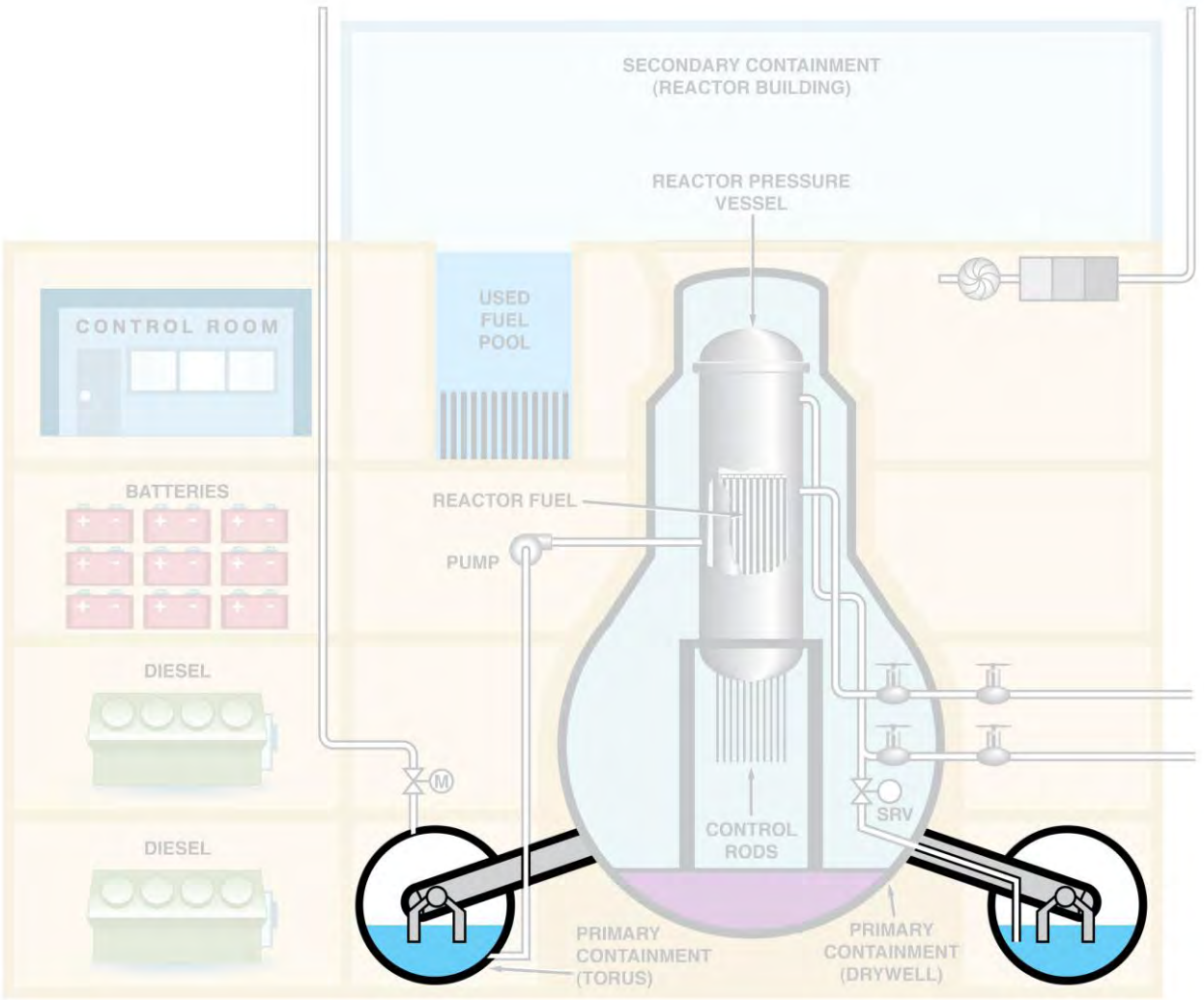
Significant Control Room Modifications after TMI – 1980



United States Design Improvements

Strengthened Torus following NRC Regulation – 1980-83

Control Room TMI – 1980

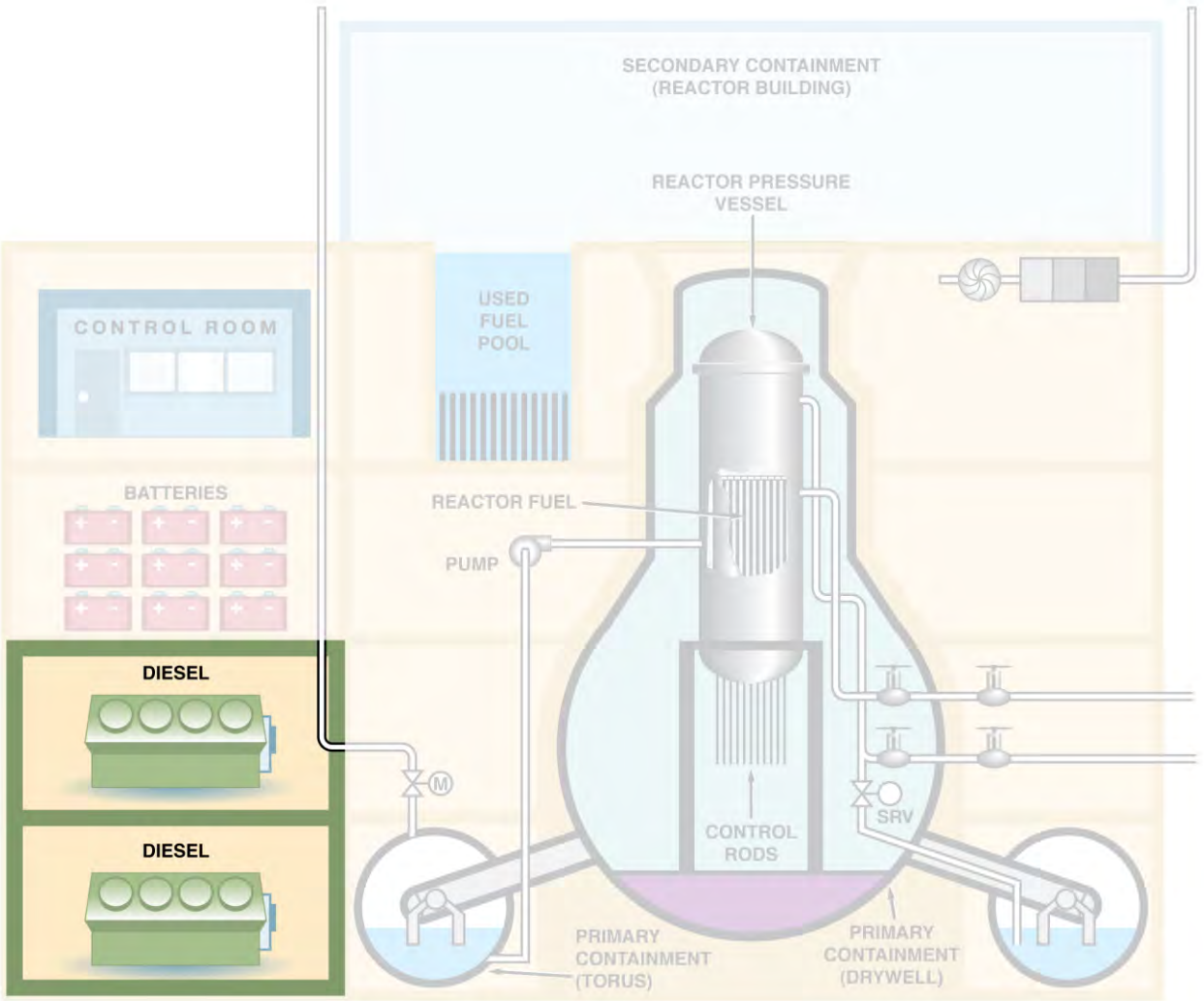


United States Design Improvements

Physical Separation of safety systems following Browns Ferry Fire – 1979

Strengthened Torus – 1980

Control Room TMI – 1980



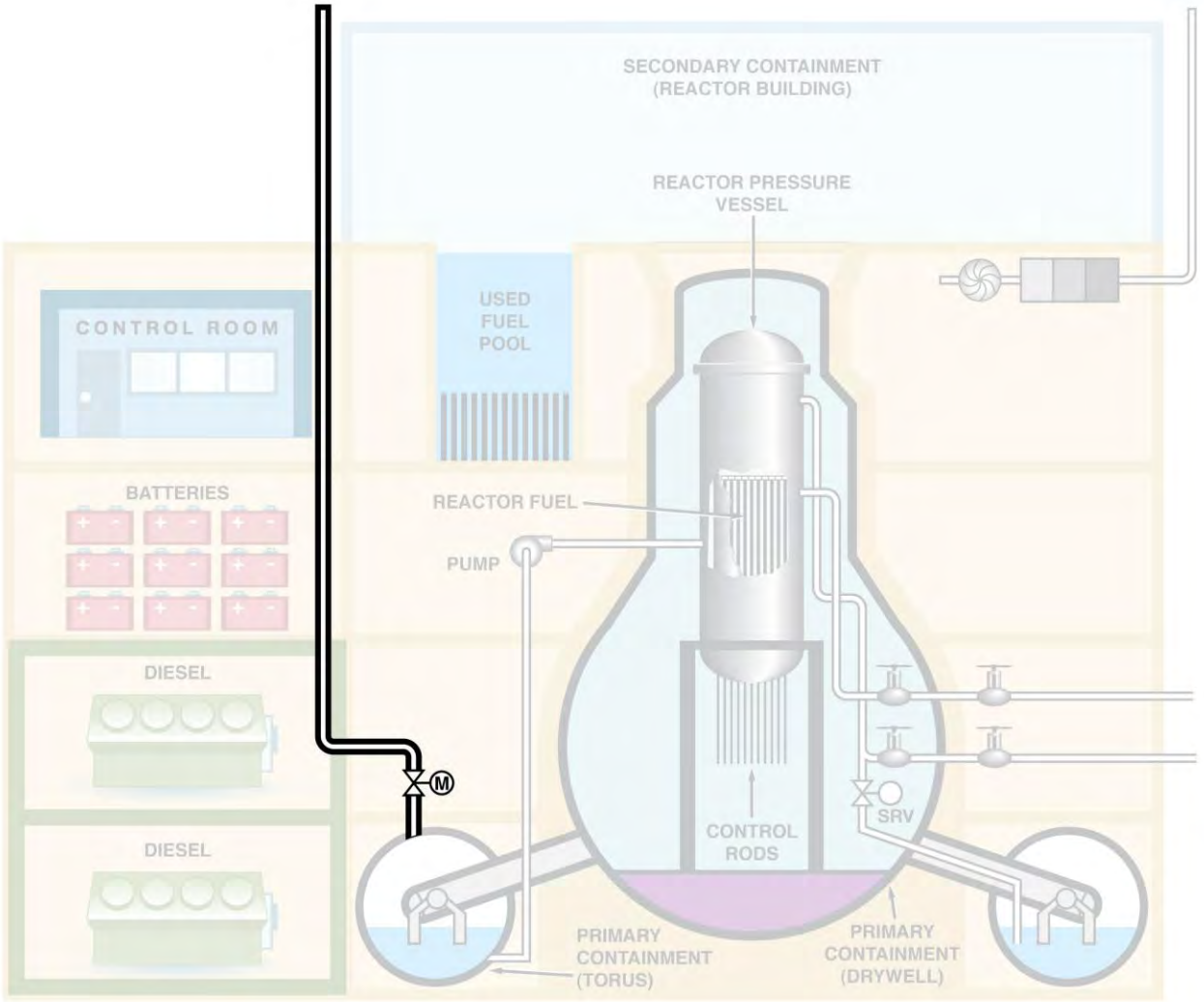
United States Design Improvements

Hardened Containment Vent to prevent H2 Buildup – 1992

Fire Protection – 1979

Strengthened Torus – 1980

Control Room TMI – 1980



United States Design Improvements

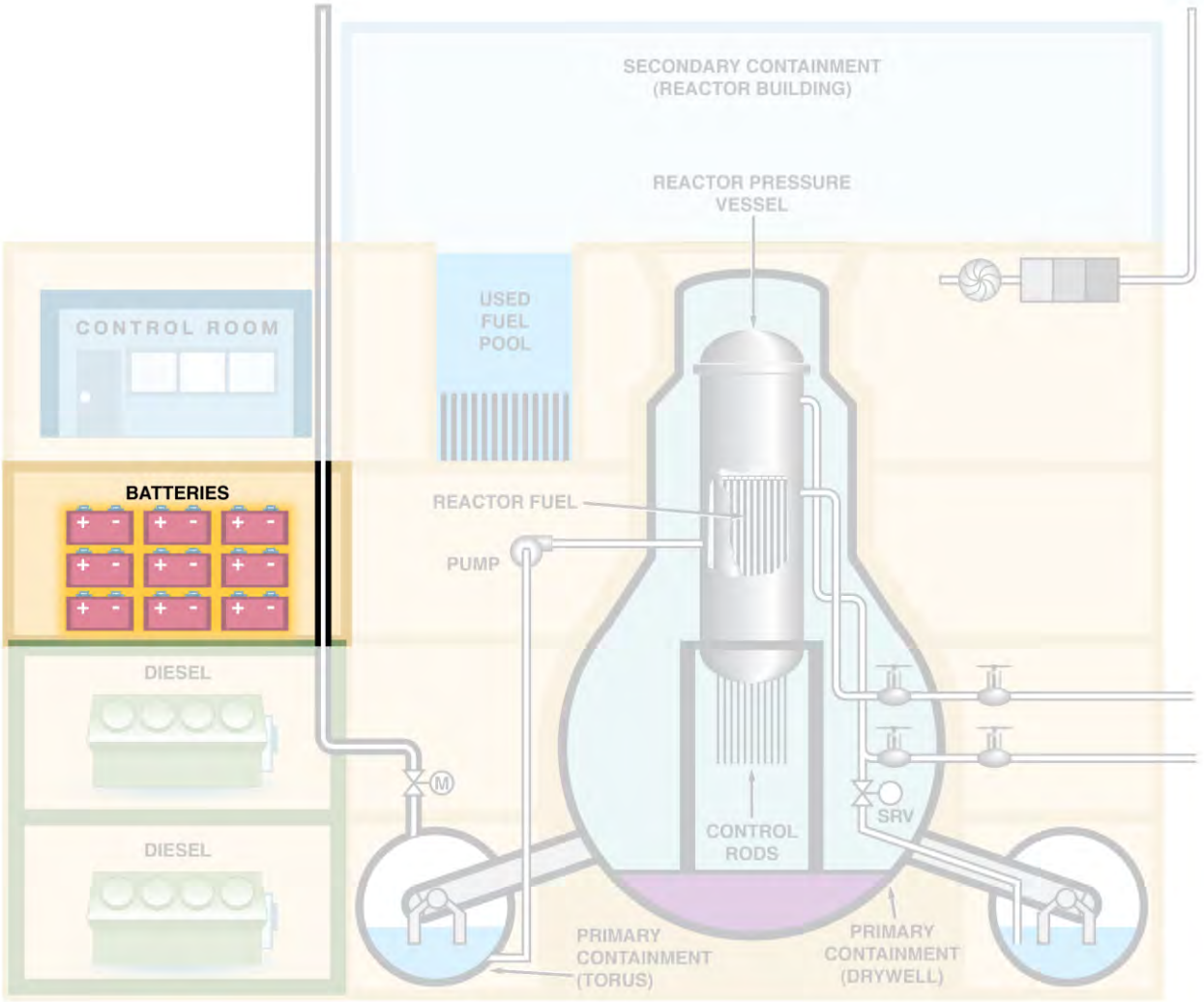
Enhanced Battery Capability for Station Black Out – 1988

Containment Vent - 1992

Fire Protection – 1979

Strengthened Torus – 1980

Control Room TMI – 1980



United States Design Improvements

Redundant Generator and Pumps following 9/11 – 2002

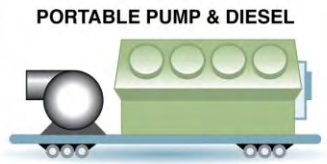
Station Black Out – 1988

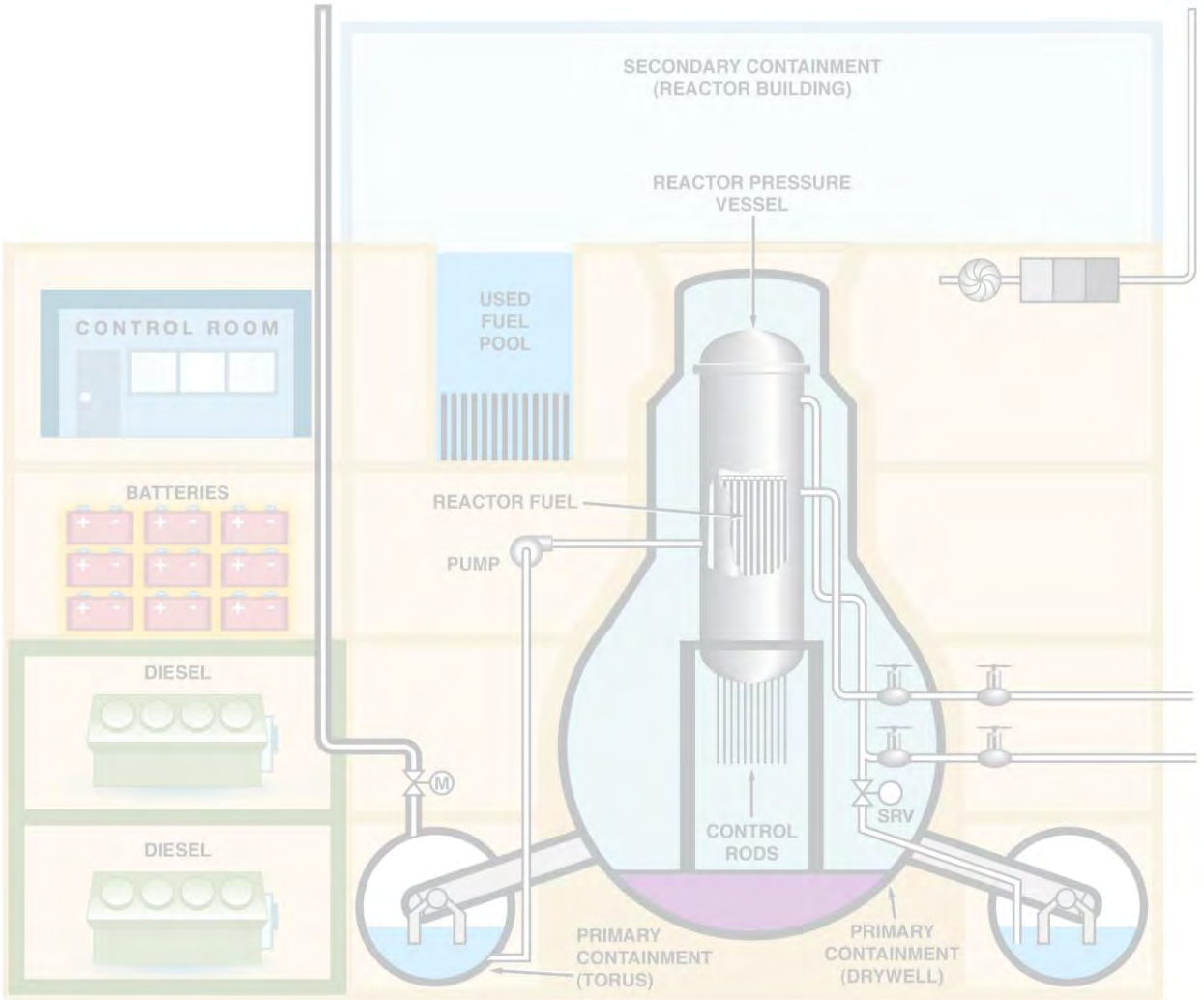
Containment Vent – 1992

Fire Protection – 1979

Strengthened Torus – 1980

Control Room TMI – 1980





United States Design Improvements

Spare Diesel / Pump – 2002

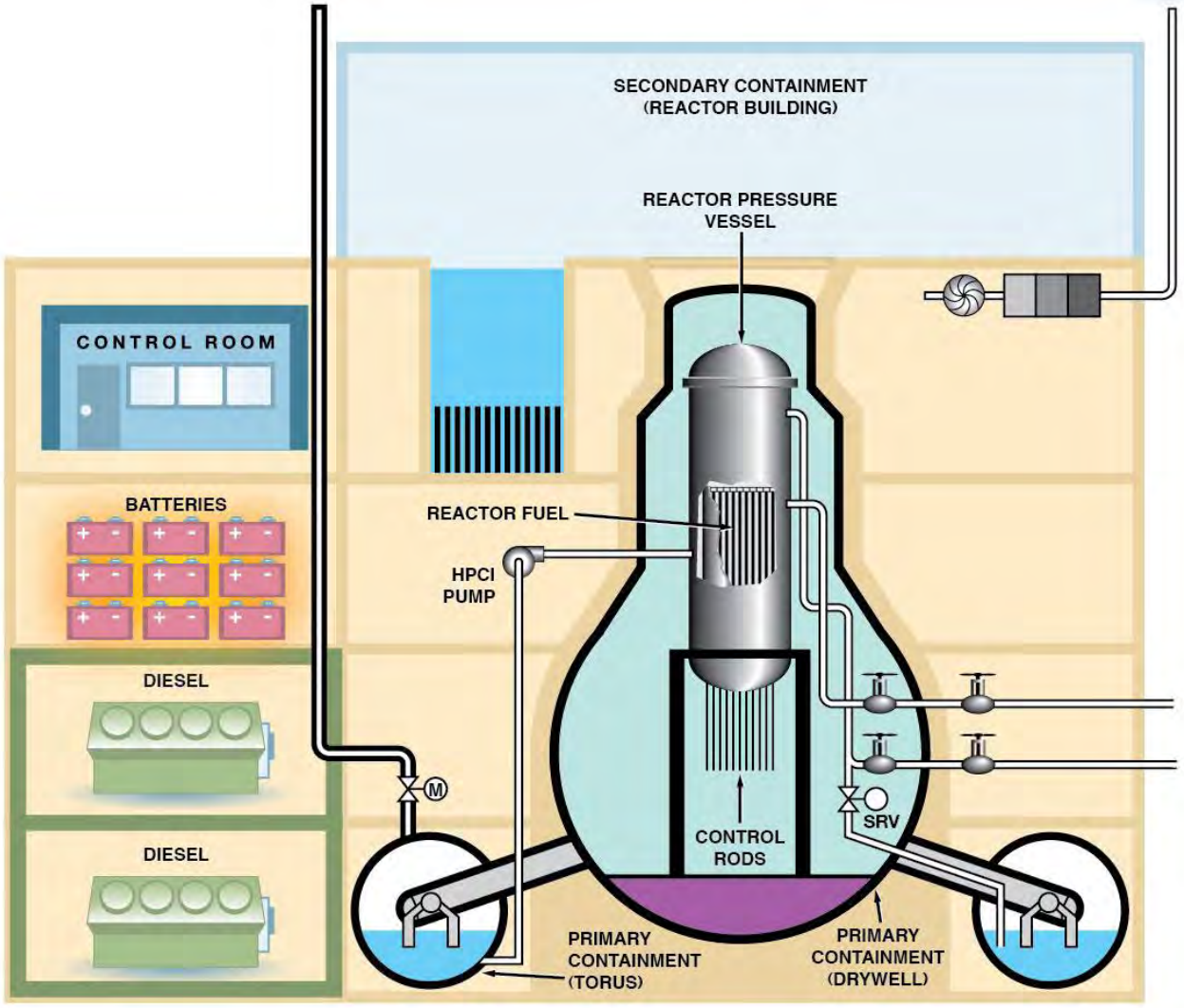
Station Black Out – 1988

Containment Vent – 1992

Fire Protection – 1979

Strengthened Torus – 1980

Control Room TMI – 1980



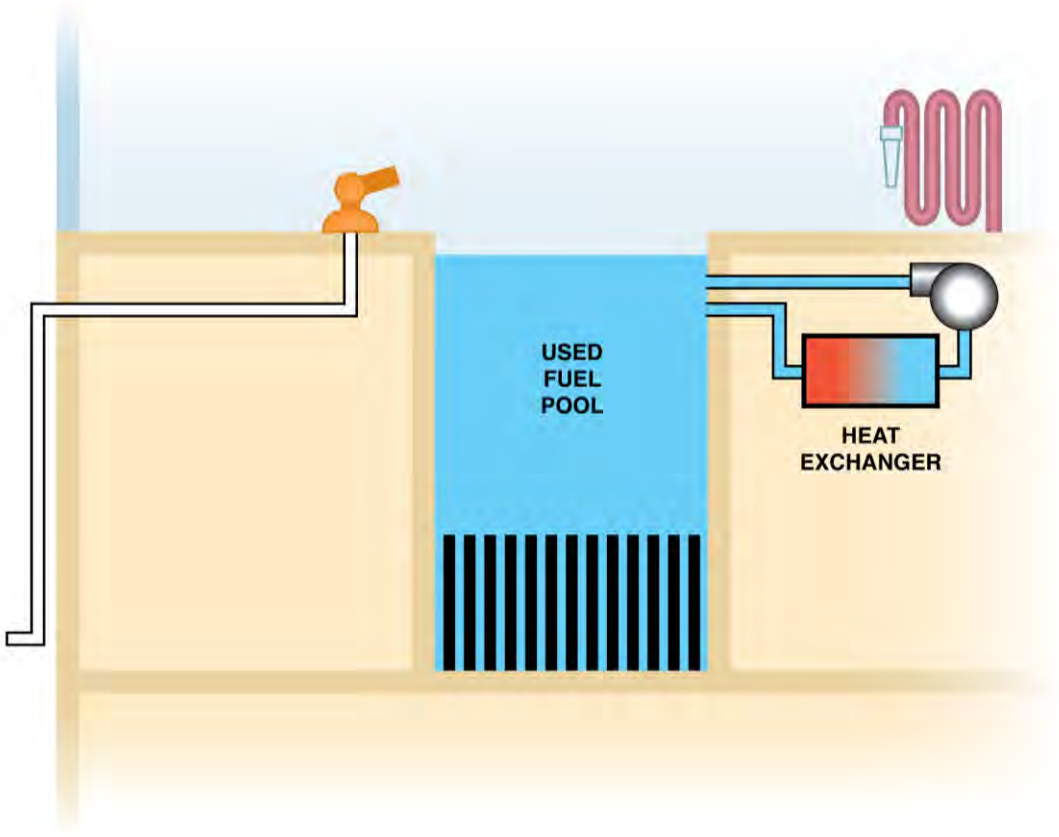
Used Fuel Pool Protection

Used Fuel Pools designed to station Design Bases criteria

Redundant pumps available to ensure used fuel pool cooling

Alternative fuel pool cooling capability added post 9/11

Multiple sources of water and power for cooling beyond design bases



Emergency Planning

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Radiation Levels are fluctuating at Fukushima Daiichi

Site Boundary

- 50 mrem/hr – spikes up to 1200 mrem/hr

Between Reactor Buildings

- 10,000 mrem/hr – 40,000 mrem/hr
  (Likely spikes following Unit 2 explosion)

Controlled venting of containment and issues with used fuel pools resulted in radiation releases

General evacuation within 12 miles / US citizens within 50 miles

Potassium Iodide tablets distributed to area residents and workers

Background

- General population receives ~600 mrem/year
- United States Nuclear worker limited to 5,000 mrem/yr
- PSEG Nuclear limits exposure to 2,000 mrem/yr

United States Emergency Planning

1978 – 10 Mile Emergency Planning Zone (EPZ) deemed appropriate

- Limited offsite agency participation – Site driven

1980 – Post TMI – NRC NUREG 0654 implemented

- Determined appropriate emergency response program
  - number required on shift / emergency facilities / offsite participation required
- Evaluated every 2 years by FEMA / NRC
- Integrated response between onsite and offsite agencies and states
- Mandated siren for alerting public and Emergency News Center
- Established 50 Mile ingestion pathway (Tested every 6 years)

2001 – Potassium Iodide recommended for protection of thyroid

- Distribution to residents within 10 miles of nuclear plant enacted

2002 – Post 9/11 Security Changes implemented

- Required greater integration of security plan and emergency plan

2006 – Battery Backup on sirens recommended

Salem / Hope Creek Site Specific Information

PSEG Power LLC

Salem – Hope Creek Seismic Design

Design Basis levels for environmental events are determined independently for every plant in the US

- Based on geographic and historic information

Salem – Hope Creek Seismic Design – 6.5 Richter Scale

- All structures, systems, and components important to plant safety will perform safety function to keep plant cool
- Re-evaluated during current License Renewal review

The largest earthquake in New Jersey occurred in 1783

- Magnitude 5.3
- Felt from New Hampshire to Pennsylvania

Salem/Hope Creek Flooding Design

Designed for flood level 22.9 ft above ground level

- Water-tight doors
- Exterior walls reinforced concrete

Max. flood predicted for Tsunami – 5.6 ft above ground level

- Coincident with High Tide and High Winds

Max. flood predicted for Hurricane – 22.9 ft above ground level

- Category 4
- Coincident with High Tide and High Winds

Normal level for Delaware River – 11 ft below ground level

- Mean Water level of river – 89ft
- Record height – 2.5 feet below ground level (1950)

Salem/Hope Creek Flood Design

PSEG Power LLC

Site Flooding Actions

Worst Case flooding event for site is Hurricane Surge

- Expect forecast >24hrs from event

Site actions planned at specific river levels, including Emergency Plan staffing if required

- 93.0 ft Local Area Road Flooding may restrict access to site and to EOF/ENC
- 95.0 ft. Salem and Hope Creek doors to be shut
- 98.5 ft Hot Standby in 6 hours
- 99.5 ft Hope Creek, Salem in Hot Shutdown in 12 and cold shutdown within following 24 hrs. Unusual Event Declared
- 124 ft Emergency Diesel Generators are impacted

Managing through a Station Blackout

Hope Creek and Salem have steam-driven pumps to deliver cooling water

- These require only steam and battery power

With operator actions, these will operate for a minimum of 8 hours (4 hours is licensing basis)

- Provides time to restore power or provide alternate cooling

Hope Creek and Salem have redundant, safety-related Emergency Diesel Generators

- Provide power in the event the grid is lost
- Fuel and Diesel Generators located in Seismic Structures
- Flood protected structures

Severe Accident Management Guidelines (SAMG)

Procedures for extraordinary events beyond the design basis of the plant that keep core cool and covered

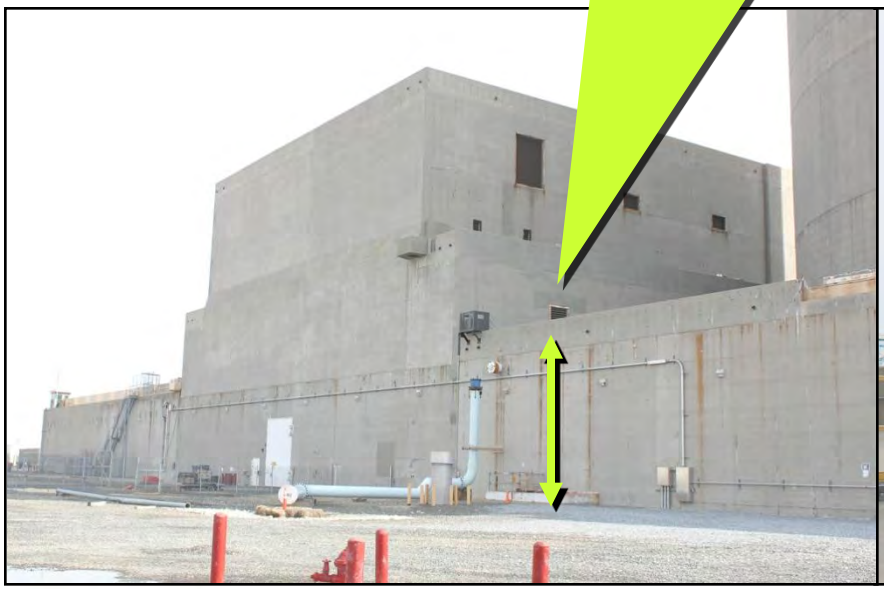
- Monitors containment and coolant conditions for proper levels and pressures. If parameters are outside of given conditions, then actions are taken to mitigate conditions.
- Multiple layers of defenses for parameter maintenance.
- Supplemental procedures to use independent diesel driven water pumps (Delaware River as source) and generators in the event of a total loss of power.

Hope Creek EDG Flood Protection Design

Hope Creek 4 Dedicated Emergency Diesel Generators protected from flooding up to 31 feet above site grade

Hope Creek Diesel Combustion Air Intakes 31 feet above site grade

Hope Creek EDG Combustion Air Intakes



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Salem Diesel Flood Protection Design

Salem Diesels protected from flooding up to 25 above site grade. Starting Air, Fuel and control systems in flood protection area.

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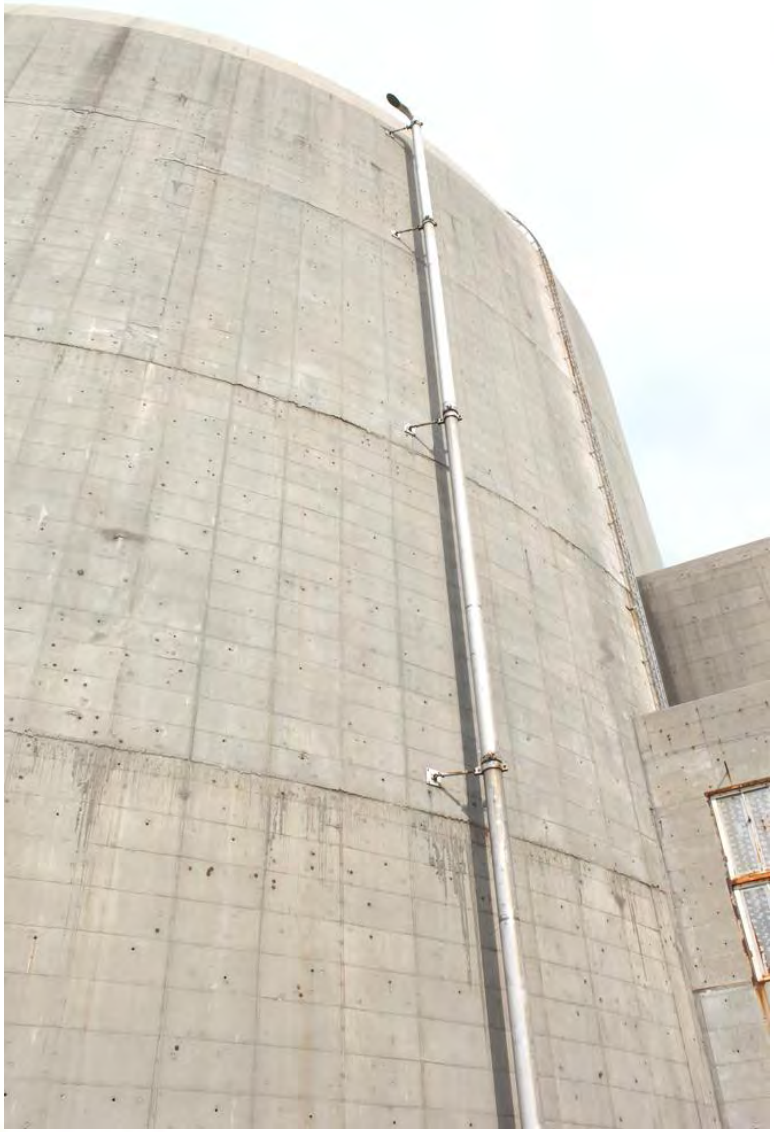
Industry Mark 1 Containment Modifications



US Industry response to Severe Accident Management Program (SAMP 1988) required implementation of hardened external torus vent to prevent hydrogen infiltration into reactor building during venting.

Alternate Makeup Fire Pump

Post 9/11 regulatory requirements included development of alternate fire protection, fuel pool and reactor vessel makeup strategies.

Photo of dedicated site portable diesel fire pump utilized in post accident event.