

GE Nuclear Energy

---

# TRACCG Application

*Y.K. Cheung*

ACRS Meeting

July 8, 2003

Rockville, Maryland



# Outline

---

- **Overview of TRACCG application methodology**
- **Short-term Decay Heat Removal**
  - ECCS/LOCA Analysis (0-2000 seconds)
- **Long-term Decay Heat Removal**
  - Containment/LOCA Analysis (0-72 hours)
- **ESBWR Anticipated Operational Occurrences (AOO) Transients**
- **Summary**

# **Overview of ECCS/LOCA Application**

---

# **Overview of Containment/LOCA Application**

---

# **Overview of AOO Application**

---

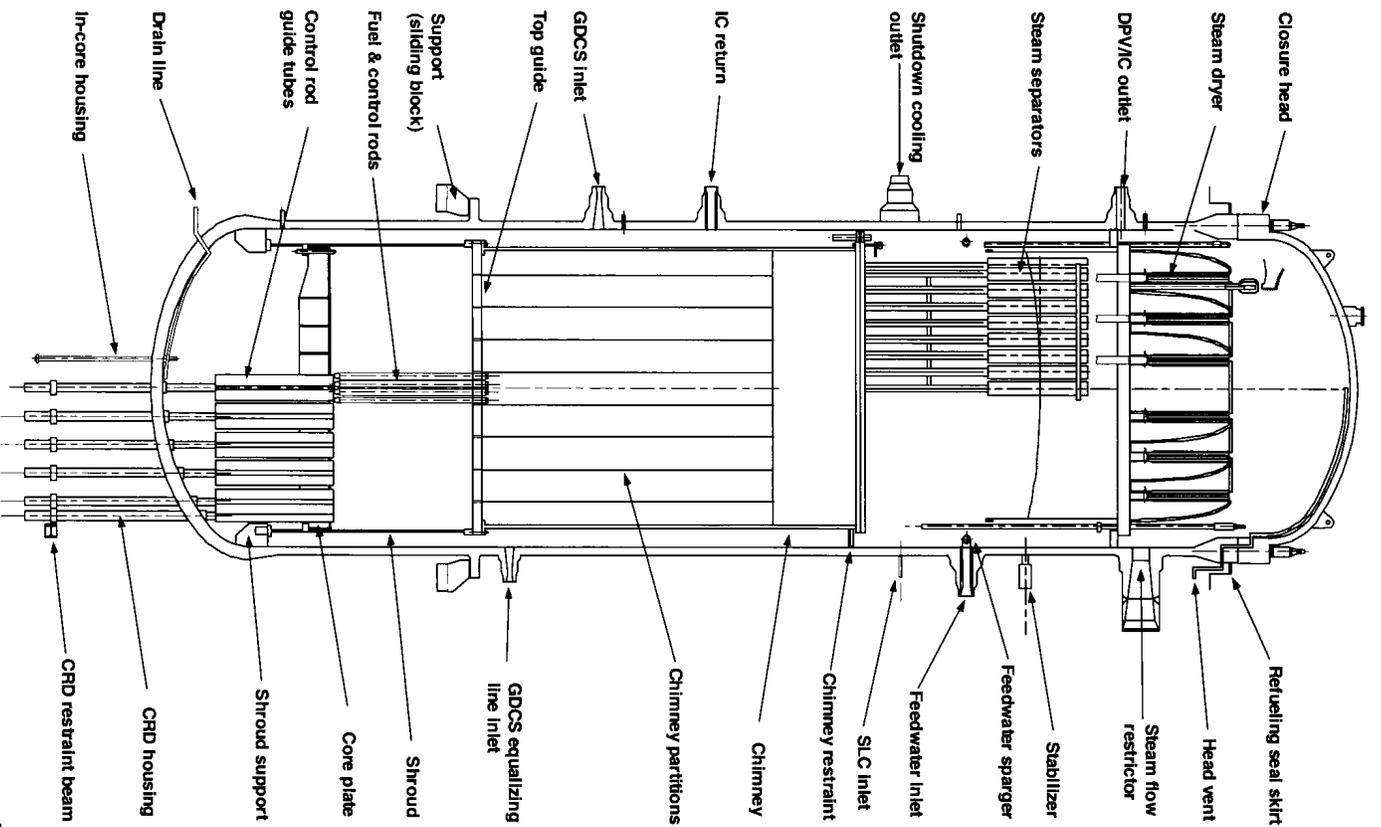
# **Decay Heat Removal During LOCA**

- **For short-term Decay Heat removal**
  - **ECCS/LOCA Analyses (0 ~ 2000 seconds)**
  - **Key measures: mixture level inside shroud and Peak Cladding Temperature**
  - **Key systems: initial water inventory inside RPV and GDCCS**
- **For long-term Decay Heat removal**
  - **Containment/LOCA Analyses (0 to 72 hours)**
  - **Key measure: Long term containment pressure**
  - **Key systems: PCCS, Drywell, Wetwell, suppression pool, and GDCCS draindown volume**

# **ECCS/LOCA Analyses**

- **Short-term Decay Heat removal (0 ~ 2000 seconds)**
- **Key design objectives**
  - Core covered by mixture at all time
  - No core heatup
- **Outline**
  - Nodalization
  - Baseline Analysis
  - Break spectrum analyses
  - Limiting Analysis
  - Summary

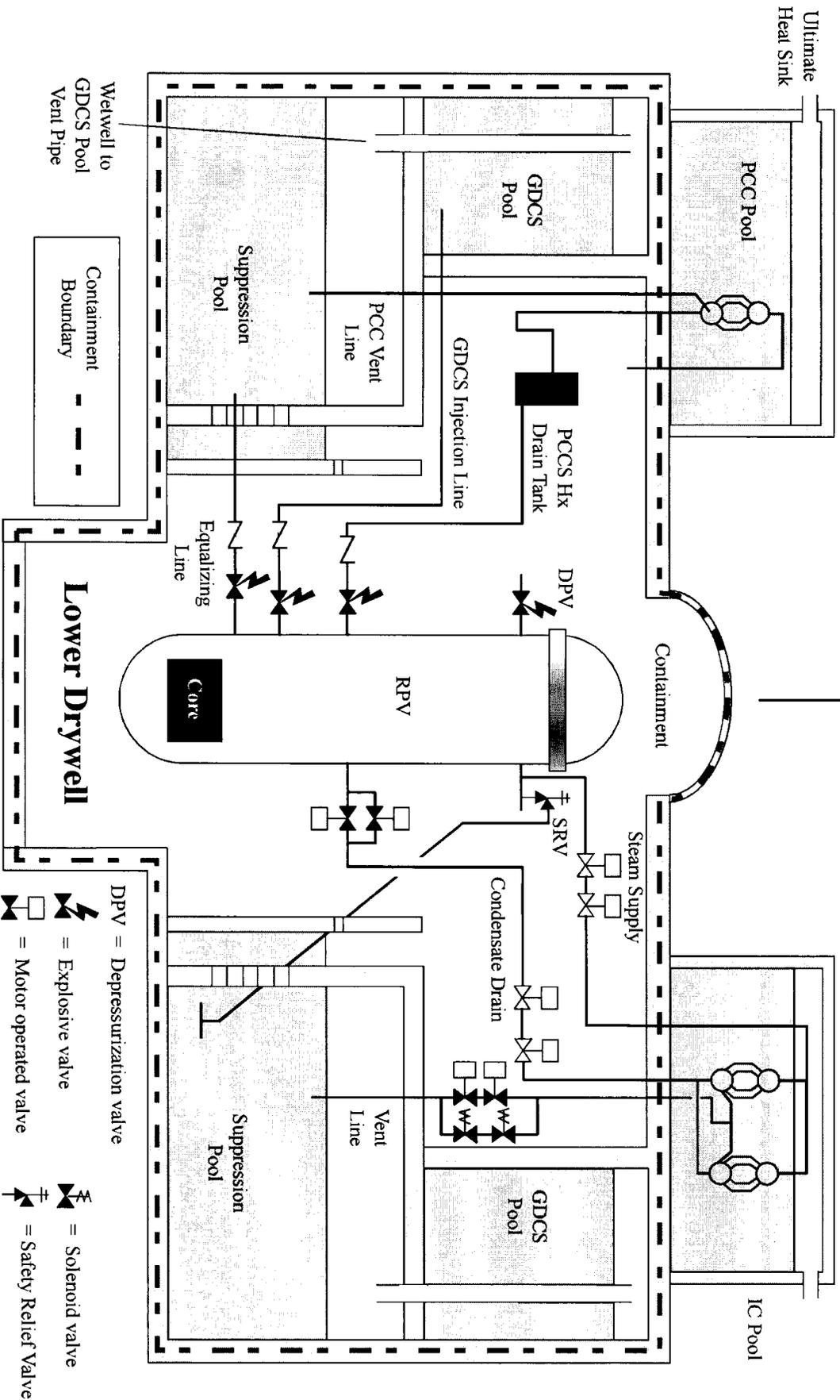
# RPV Key Features



# Containment Key Features

Passive Containment Cooling System (PCCS)  
and  
Gravity Driven Cooling System (GDCS)

Isolation Condenser System (ICS)



# **ECCS/LOCA Nodalization**

---

# **Substantial Initial Water Inventory inside RPV**

# **ECCS/MLOCA Baseline Case**

---

- **GDCCS line break with 1 GDCCS injection valve failure**
  - Nominal plant/initial conditions
  - 4 PCCCS
  - No credit for ICs
  - Assumed 1 GDCCS injection valve fail to open

# **RPV Pressure Response (Base Case)**

---

# **Two-Phase Levels in Downcomer and Inside Core Shroud (Base Case)**

---

## **Two-Phase Level and Static Head Inside Shroud (Base Case)**

## **Two-Phase Level and Static Head Inside Shroud (Cont.)**

---

# **Scoping ECCS/LOCA Break Spectrum Analysis**

---

# Limiting ECCS/MOCA Analysis

---

- **GDCS line break**
  - Same assumptions for Baseline case, except
  - Bounding Plant/initial conditions
  - Significant modeling parameters
    - **lower plenum wall heat transfer**
    - **interfacial heat transfer in the core**
    - **interfacial shear in the downcomer**
    - **interfacial heat transfer in the downcomer**
    - **interfacial shear in the chimney**
    - **channel to bypass leakage flow**

**Two-Phase Levels in Downcomer and Inside Core Shroud  
(Limiting Case)**

---

## **Two-Phase Level and Static Head Inside Shroud (Limiting Case)**

# **ECCS/LOCA Analyses - Summary**

# **Containment/LOCA Analyses**

---

- **Long-term decay heat removal (0 – 72 hours)**
- **Key design objectives**
  - Peak DW pressure below the design value (60 psia)
- **Outline**
  - Nodalization
  - Baseline Analysis
  - Sensitivity Study
  - Bounding Analysis
  - Summary

**Containment/  
LOCA  
Nodalization**

---

# Containment/LOCA – Baseline Analyses

---

- **Main Steam Line Break**
  - Minimum effective Wetwell volume

=> Highest containment pressure
- **Case assumptions**
  - 4 PCCs
  - No credit for the ICs
  - Nominal value for plant parameters
  - Small leakage path was assumed between DW and WW
- **Conservative modeling assumptions**
  - suppression pool stratification, wetwell gas space stratification

**Results for Baseline Containment/LOCA Analysis  
Containment Pressure Response (Base Case)**

---

## **PCCS Heat Removal vs. Decay Heat (Base Case)**

---

# Suppression Pool Temperatures (Base Case)

---

# Containment/LOCA – Bounding Analyses

---

- **Main Steam Line Break**
- **Case assumptions**
  - Same as the baseline case, except
  - Bounding value for plant parameters
- **Bounding Case**
  - Bounding value for model parameters used
    - Critical flow
    - decay heat multiplier
    - surf. H.T
    - PCC inlet loss ( $k/A^2$ )
    - PCC H.T.
    - V.B. Loss, ( $k/A^2$ )

# **Results for Bounding Containment/LOCA Analysis**

---

## **Drywell Pressure Response vs. Design Limit**

---

# **Containment/LOCA Analyses Results**

---

# **Containment/LOCA Analyses - Summary**

---

## **ESBWR Anticipated Operational Occurrences (AOO) Transients**

---

- **Overall analysis approach**
  - Consistent with the Code Scaling Applicability and Uncertainty (CSAU) methodology
  - Identical to the approved process for operating BWRs
- **Large steam volume in ESBWR chimney region, resulting in milder transient responses comparing to operating plants**
  - And smaller  $\Delta$ CPR
- **Sample Pressurization Transient Analysis presented here**
  - Generator load rejection with failure of all bypass valves to open (LRNB)
  - Used an earlier core design of ESBWR
    - 4000 MWth, 1132 fuel bundles, GE12 10x10 fuel
    - 9ft active core height
- **AOO calculations using ESBWR specific conditions are on going**

## **Generator load rejection with failure of all bypass valves to open (LRNB)**

**Generator load rejection with failure of all bypass valves to open (LRNB)**

## **ESBWR AOO Transients - Summary**

---

- **Comparing to operating plants, ESBWR has larger steam volume, milder transient responses**