# Emergency Core Cooling System Wrapup

Chapter 10.5

# Objectives

1. Recognize the integrated ECCS response to small, intermediate, and large break Loss Of Coolant Accidents (LOCAs).
2. List the ECCS acceptance criteria.
3. Describe the ECCS Design Basis.
4. Describe the electrical division assignments of the ECCS.
5. List the ECCS initiation signals.

# Purpose

Provide adequate core cooling during loss of coolant accident (LOCA) conditions such that:

- The amount of fuel damage is limited therefore,
- The release of radioactive materials to the environment does not exceed 10CFR-100 limitations

# ECCS Acceptance Criteria 10CFR-50.46

The ECCS shall be designed to respond to the entire spectrum of postulate pipe breaks such that:

- Peak clad temperature shall not exceed 2200 ºF
- Peak clad oxidation shall not exceed 17% of the original thickness
- Peak hydrogen generation shall not exceed 1% of maximum theoretical
- A coolable geometry is maintained
- Long term core cooling can be maintained

# ECCS DESIGN BASIS

Protection is provided for any postulated primary pipe break size.

Two independent cooling methods (spray and flooding)

One high pressure system capable of preventing ADS for small line breaks

No operator action is required for 10 minutes

A sufficient water source such that the containment and reactor vessel core can be flooded

No single active component failure shall prevent automatic initiation

# ECCS DESIGN BASIS

Long term (> 10 minutes) cooling while sustaining one failure

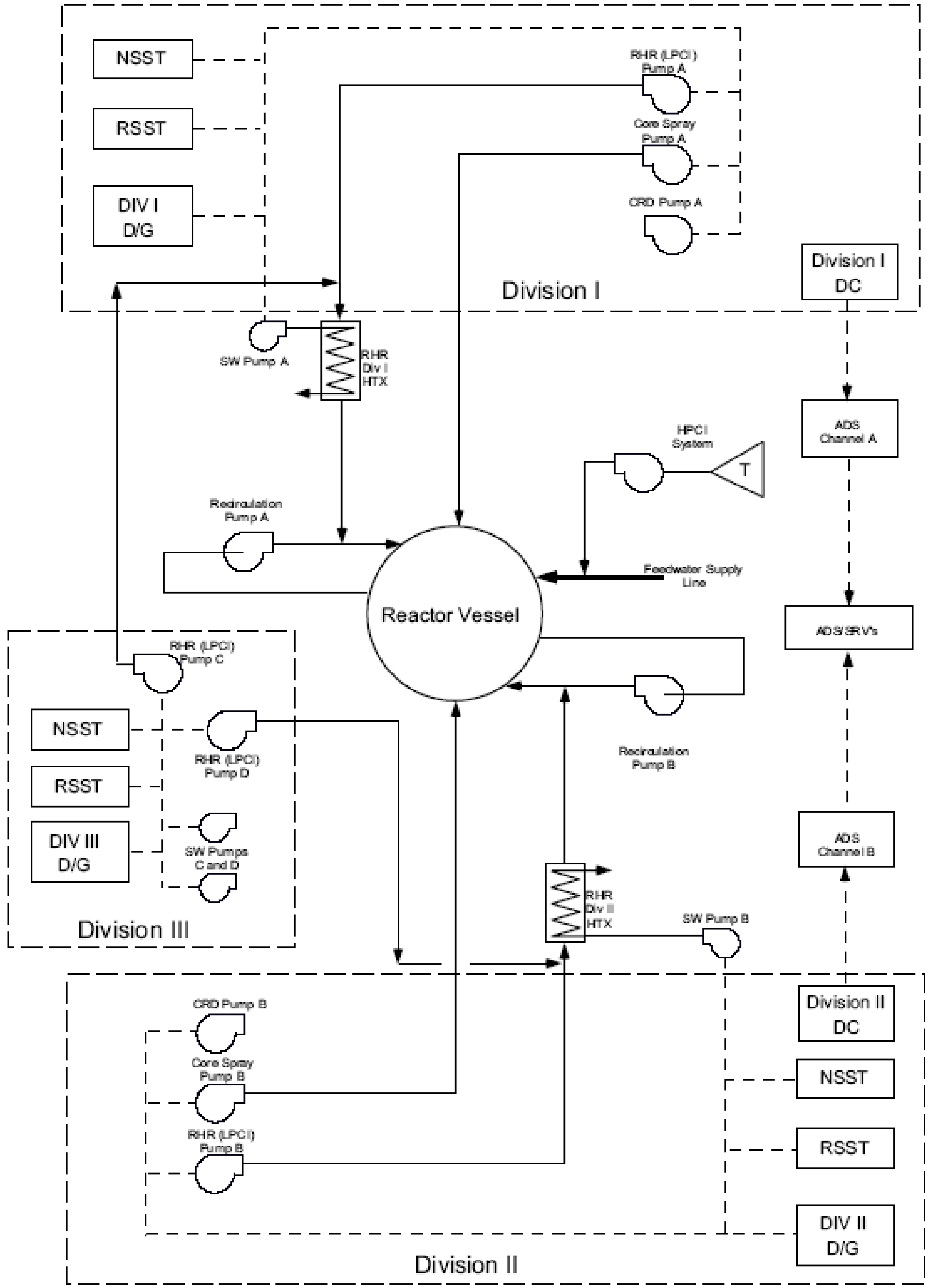
Satisfying the above requirements even with LOOP

Non ECCS loads shall be shed and/or inhibited while a LOCA signal exists

All active components shall be testable

Components within the reactor vessel shall be designed to withstand the transient mechanical loadings

Figure 10.5-2

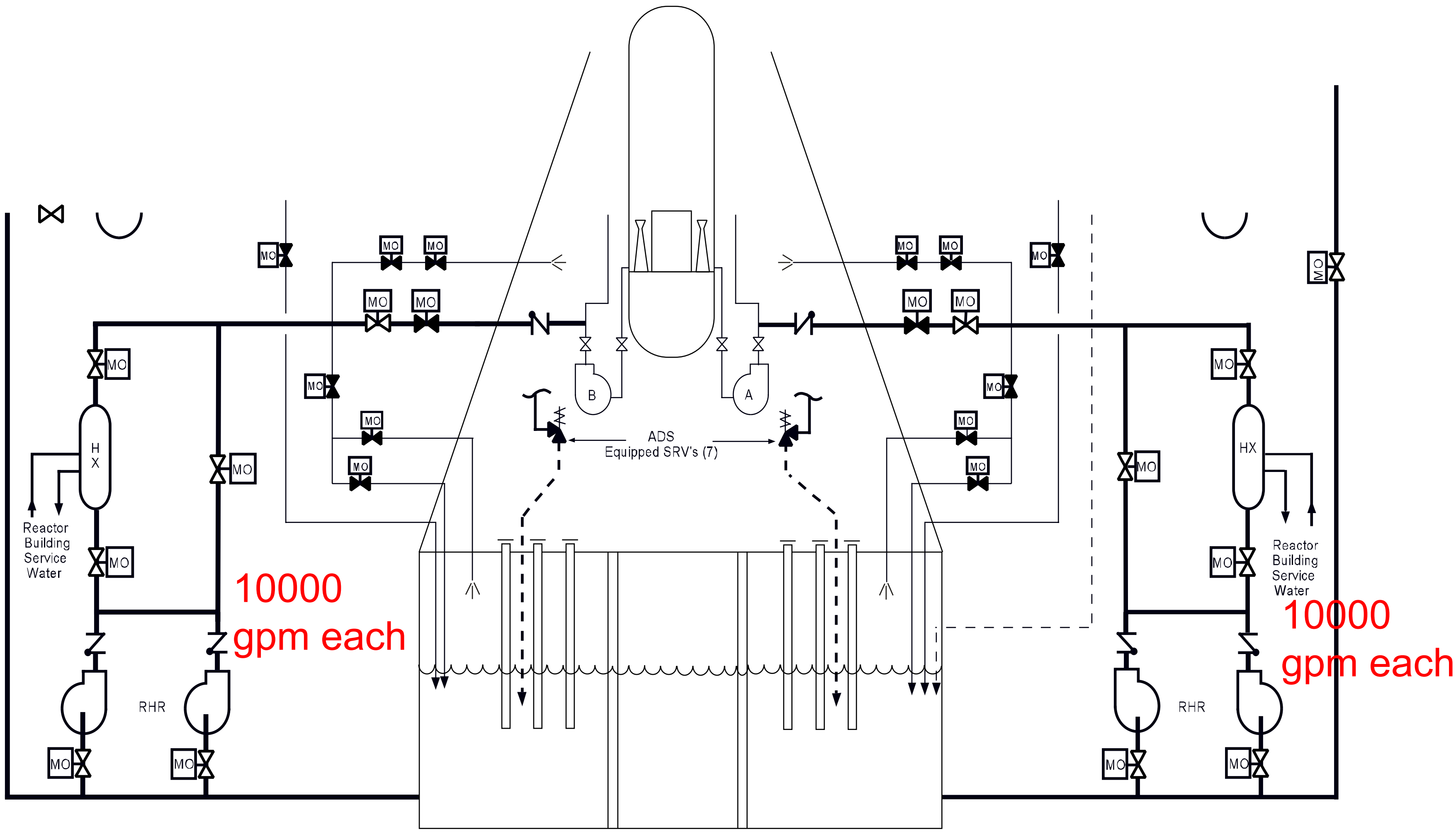



ECCS Divisional Assignments

Figure 10.5-1

# Integrated ECCS

LO
•Lc
•Hi



# INTEGRATED RESPONSE

Small break LOCA within HPCI capacity:

- Reactor Scram and HPCI start at 1.69 psig drywell pressure.
- HPCI (and feedwater) able to restore post scram level and all trip on level 8
- HPCI and bypass valves able to accommodate core decay heat
- Inventory loss due to decay heat results in level 2 and HPCI reinjects. (cycles L-2 to L-8)

# INTEGRATED RESPONSE

Small break LOCA with HPCI not available:

- Reactor Scram at 1.69 psig drywell pressure.
- Feedwater able to restore post scram level and trips on level 8
- Bypass valves able to accommodate core decay heat
- Inventory loss due to decay heat results in level 1 which starts RHR, CS and ADS timer and closes MSIV’s
- ADS depressurizes RPV resulting in CS and RHR injection
- RPV flooded to steam lines then SRV’s and back to Suppression Pool.

# INTEGRATED RESPONSE

## Intermediate break LOCA exceeding HPCI capacity:

- Reactor Scram at 1.69 psig drywell pressure.
- HPCI and Feedwater able to restore post scram level and trips on level 8
- Bypass valves able to accommodate core decay heat
- HPCI restarts at Level 2 and slows level trend.
- Inventory loss due to decay heat results in level 1 which starts RHR, CS and ADS timer and closes MSIV’s
- ADS depressurizes RPV resulting in CS and RHR injection
- RPV flooded to steam lines then SRV’s and back to Suppression Pool.

# The assumptions for the DBA-LOCA are:

- Effective break size equal to 2/3 of a double ended rupture of a recirculation pump discharge line.
- The calculated flow area for this break is 1.3 $ft^2$.
- The location effectively disables the RHR division for that Recirculation loop.
- 105% thermal power, 1055 psia and reactor water level at +12.5 inches.
- Worst case fuel thermal limits and decay heat.
- Loss of all off site electrical power.
- Failure of the LPCI injection valve to open for the RHR division on the intact recirculation system.

# Table 10.5-1 Operational Sequence of Emergency Core Cooling Systems

| Time (secs) | Event |
|---|---|
| 0 | Design basis Loss of Coolant Accident starts; normal auxiliary power lost. |
| 0 | Drywell high pressure and reactor water Level 3 is reached. All diesel generators start; reactor scram; HPCI, CS, LPCI signaled to start on high drywell pressure. |
| 3 | Reactor water Level 2 is reached. Reactor Recirculation pumps trip. HPCI receives second signal to start. |
| 6-8 | Reactor water Level 1 is reached. MSIVs close, second signal to start LPCI and CS; ADS sequence begins. |
| 13 | EDGs ready for loading. 480v Emergency Switchboards energized. All 4 RHR pumps start in LPCI mode. |
| 14 | Fuel completely steam blanketed. |
| 20 | Signal for both CS pumps to start. |
| 22 | RPV reaches 465# and 338#, signals the CS and LPCI injection valves to open. |
| 26 | RPV pressure at 310# signals the Recirc discharge valves begin to close. |
| 30 | HPCI injection valve open and pump at design flow, which completes HPCI startup. |
| 46 | One RHR (LPCI) pump injection valve is open. (Worst case failure is failure of the injection valve on the intact Recirc loop.) CS pumps at rated flow, LPCI and CS injection valves open, which completes the LPCI and CS startup. |
| 62 | Recirc line valves fully closed. |
| 108 | Water level restored to above top of active fuel. |

# INTEGRATED RESPONSE

## Large break (DBA) LOCA:

- Reactor Scram at 1.69 psig drywell pressure.
- HPCI and Feedwater quickly lose motive steam
- All decay heat dissipated through leak
- Inventory loss due to break and decay heat results in level 1 which starts RHR, CS and ADS timer and closes MSIV’s
- ADS not necessary as reactor depressurizes through break
- RHR and CS inject as discharge valves are opening.
- RPV flooded to at least 2/3 core height, overflow jet pump throats, out the break and back to Suppression Pool.

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# QUESTIONS?