

# Part 52 Design Certification

US NRC  
Framatome ANP

March 13, 2002  
Rockville, MD

  
FRAMATOME ANP

# Agenda

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- ◆ **Background, Purpose, & Introduction**
- ◆ **Presentation of the SWR 1000**
- ◆ **Discussion of Certification Process**
- ◆ **Discussion of Key Technical Points**
- ◆ **Future Interactions with the NRC**

# Background

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- ◆ Framatome ANP plans to submit an Application for Design Certification of the SWR 1000
- ◆ Work on the Design Certification Application will be initiated in early 2003

# Meeting Purpose

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- ◆ Provide NRC information necessary for resource scheduling
- ◆ Begin Defining Process and Schedule for Design Certification
- ◆ Begin Defining Content of Design Certification Application



# Specific Objectives

- ◆ **We Seek Clear Policy Statements on the Following:**
  - ◆ NRC position on the application of PRA and its relationship to Regulatory Treatment of Non-Safety Systems
  - ◆ NRC position on the treatment of potential reactor vessel failure
  - ◆ NRC position on the treatment of passive systems
  - ◆ Influence of new security measures on plant design
  - ◆ Criteria for Acceptance of: non-US Codes & Standards, and Testing

# Introduction

**Framatome ANP, Inc.**



**A**

**FRAMATOME ANP**

**is**

**○ An American Company That  
Is Part of a Global Family**

**○ The Largest Nuclear  
Component, Systems, Services  
and Fuel Company in the**

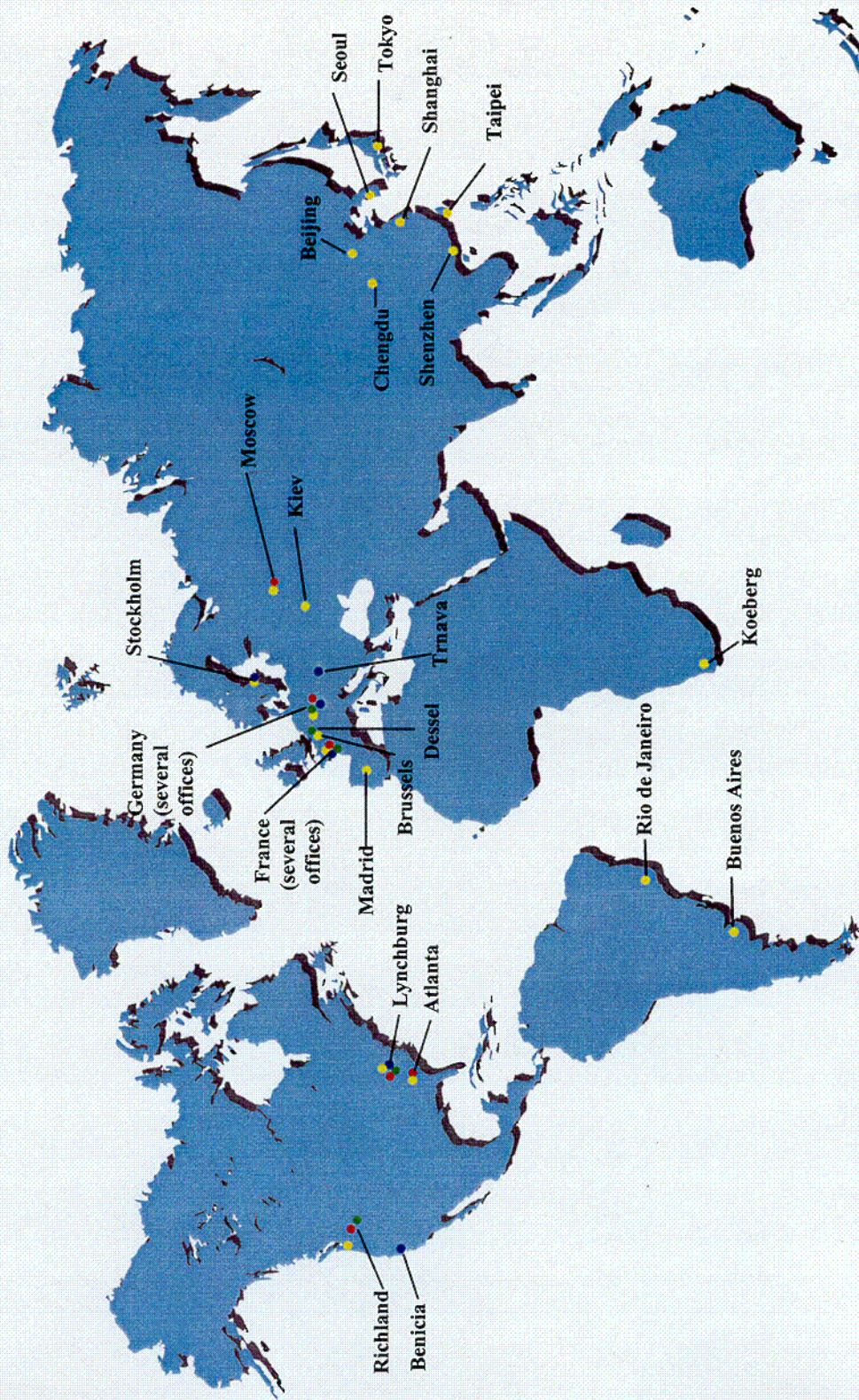
**World**

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**FRAMATOME ANP**



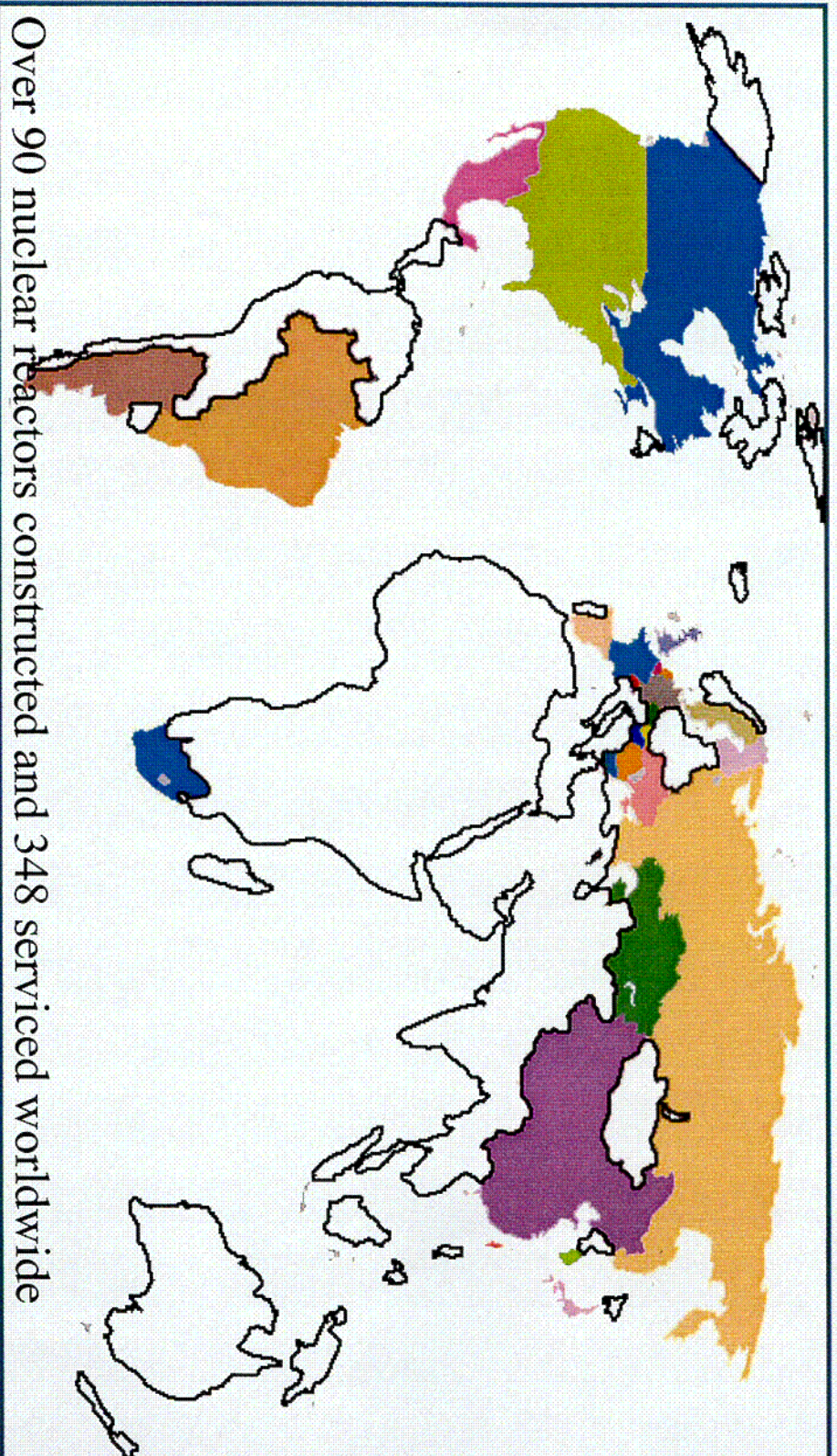
# Framatome ANP: 13,000 Employees Worldwide



• Engineering • Manufacturing • Services • Offices



## Comprehensive Nuclear Services Worldwide



Over 90 nuclear reactors constructed and 348 serviced worldwide

Framatome ANP is active virtually everywhere there is commercial nuclear power



# Recent Framatome ANP Plants

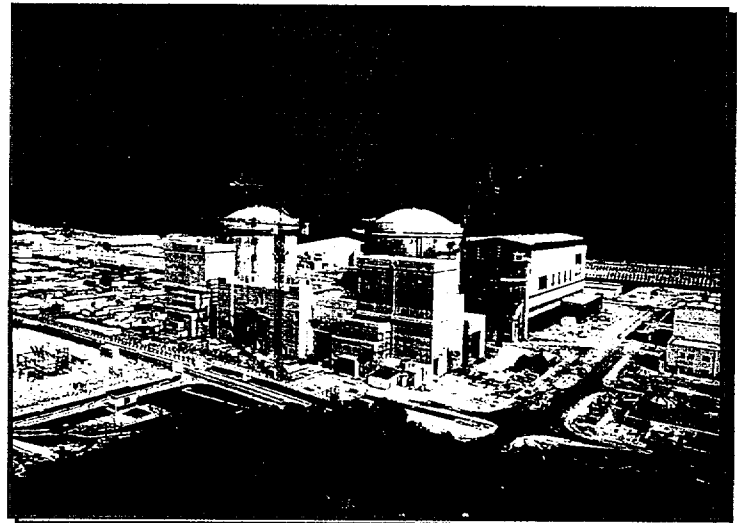


## Daya Bay

2 Units  
944 MWe PWR  
Commercial - 1994 (Both Units)

## Ling Ao

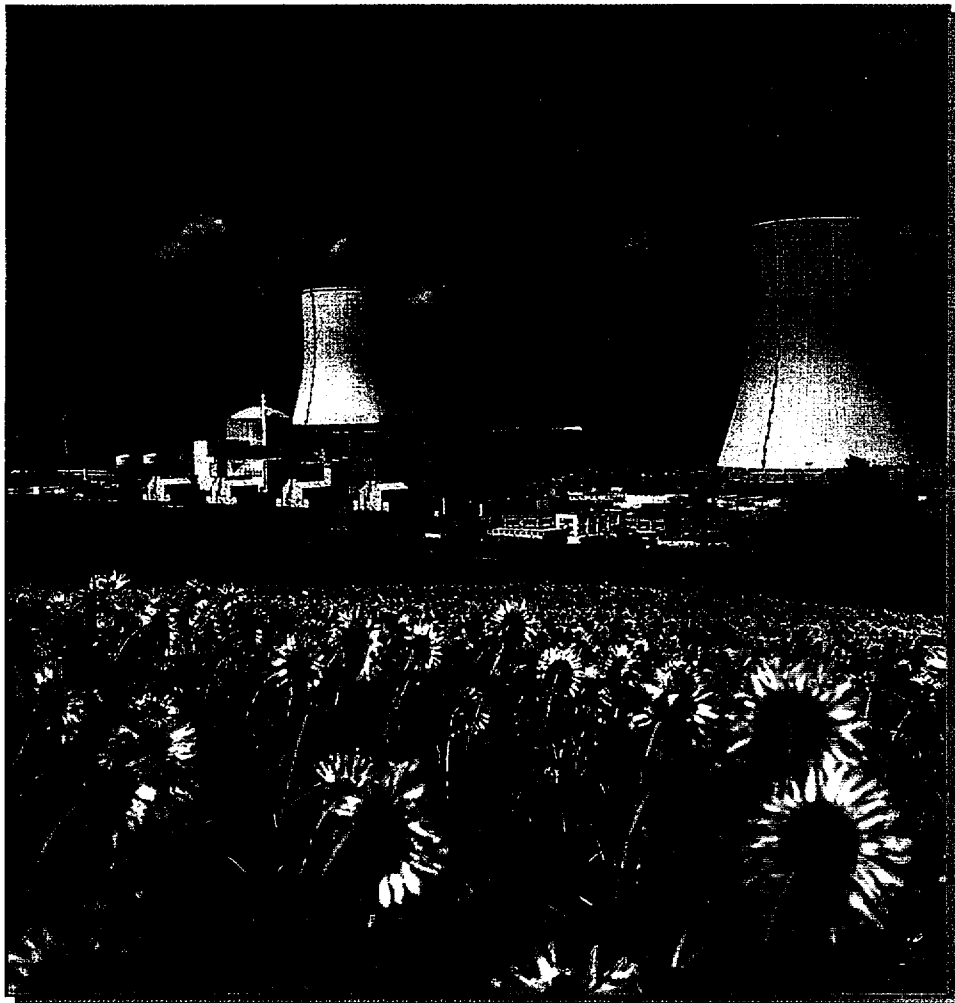
2 Units  
935 MWe PWR  
Unit 1 - Commercial - 2002  
Unit 2 - Commercial - 2003



Since 1990, 28 new LWR's (non VVER) have been started up, 13 of which are Framatome ANP

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# Recent Framatome ANP Plants



## Civaux - N4 Plant

2 Units

1450 MWe PWR

Unit 1 - Commercial - 1997

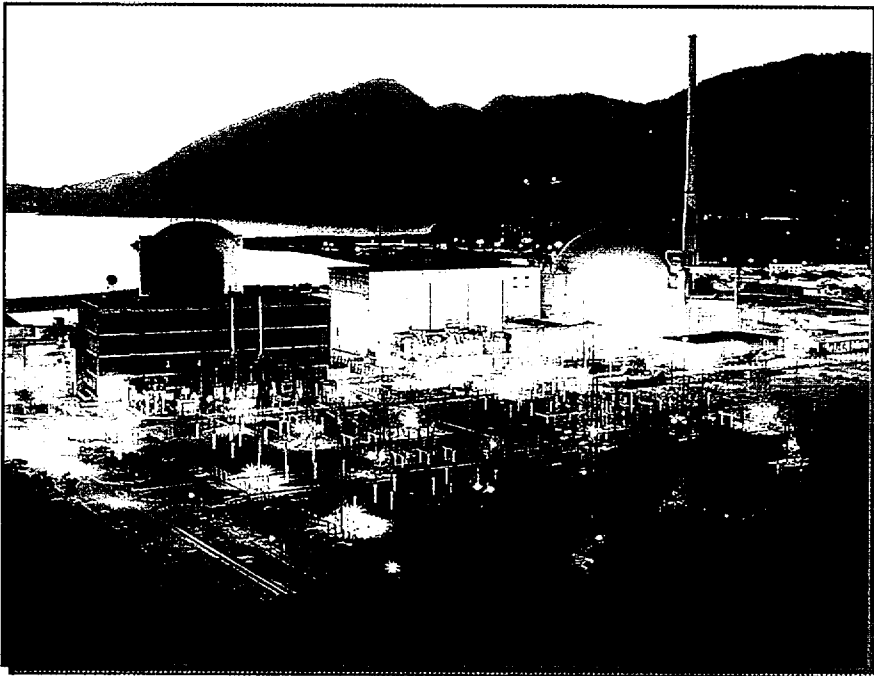
Unit 2 - Commercial - 1999

Two of the highest power nuclear units in the world



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# Recent Framatome ANP Plants



- Contract Signed in 1976
- Site Activity Begun in 1977
- Construction Suspended in 1985 at ~70% Completion
- Decision to Complete in 1995
- Site Work Resumed in 1996
- Commercial Operation in 2002

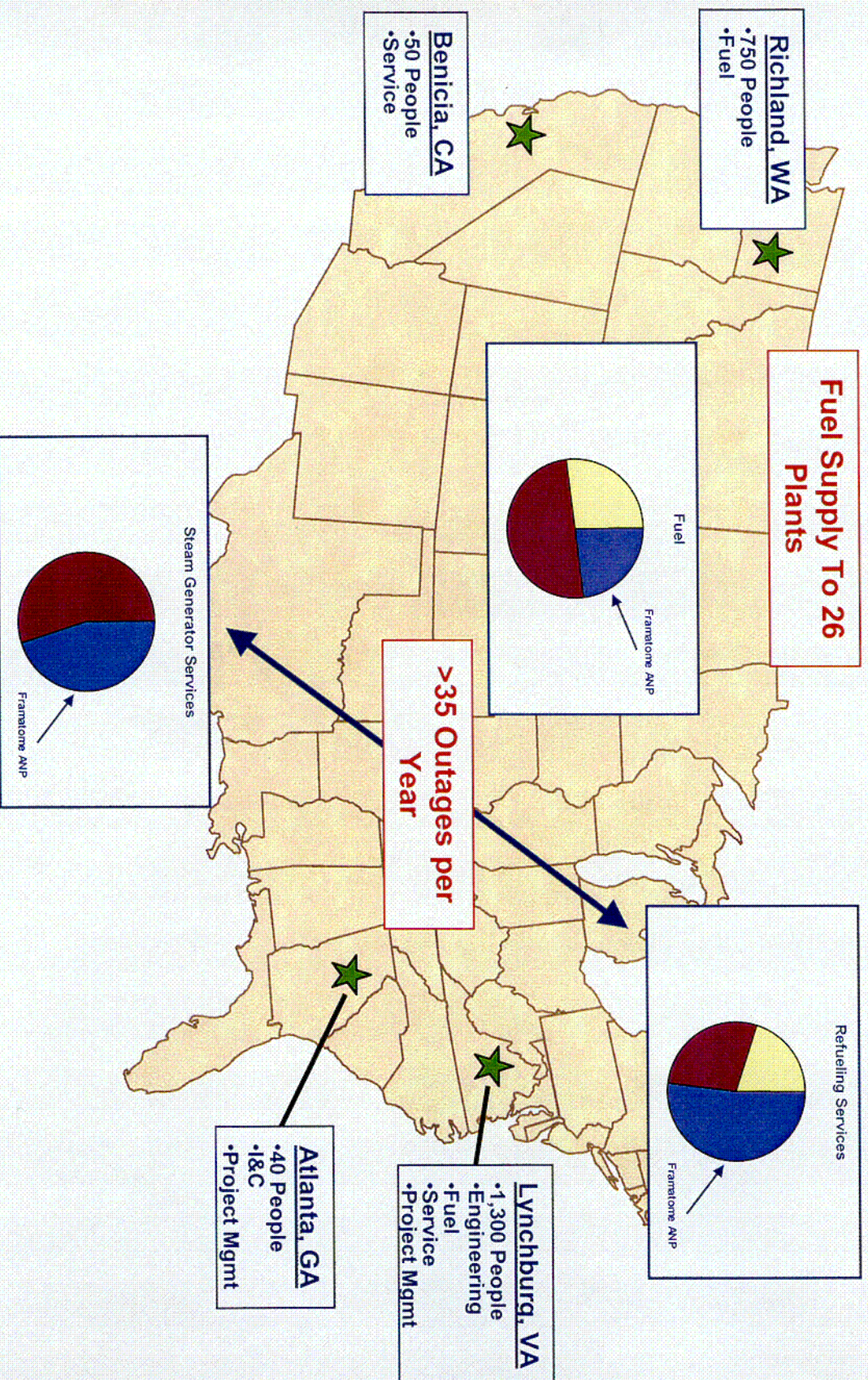
## **Angra 2**

1229 MWe PWR

**Framatome ANP has Recent Experience Completing Suspended Nuclear Power Plants**

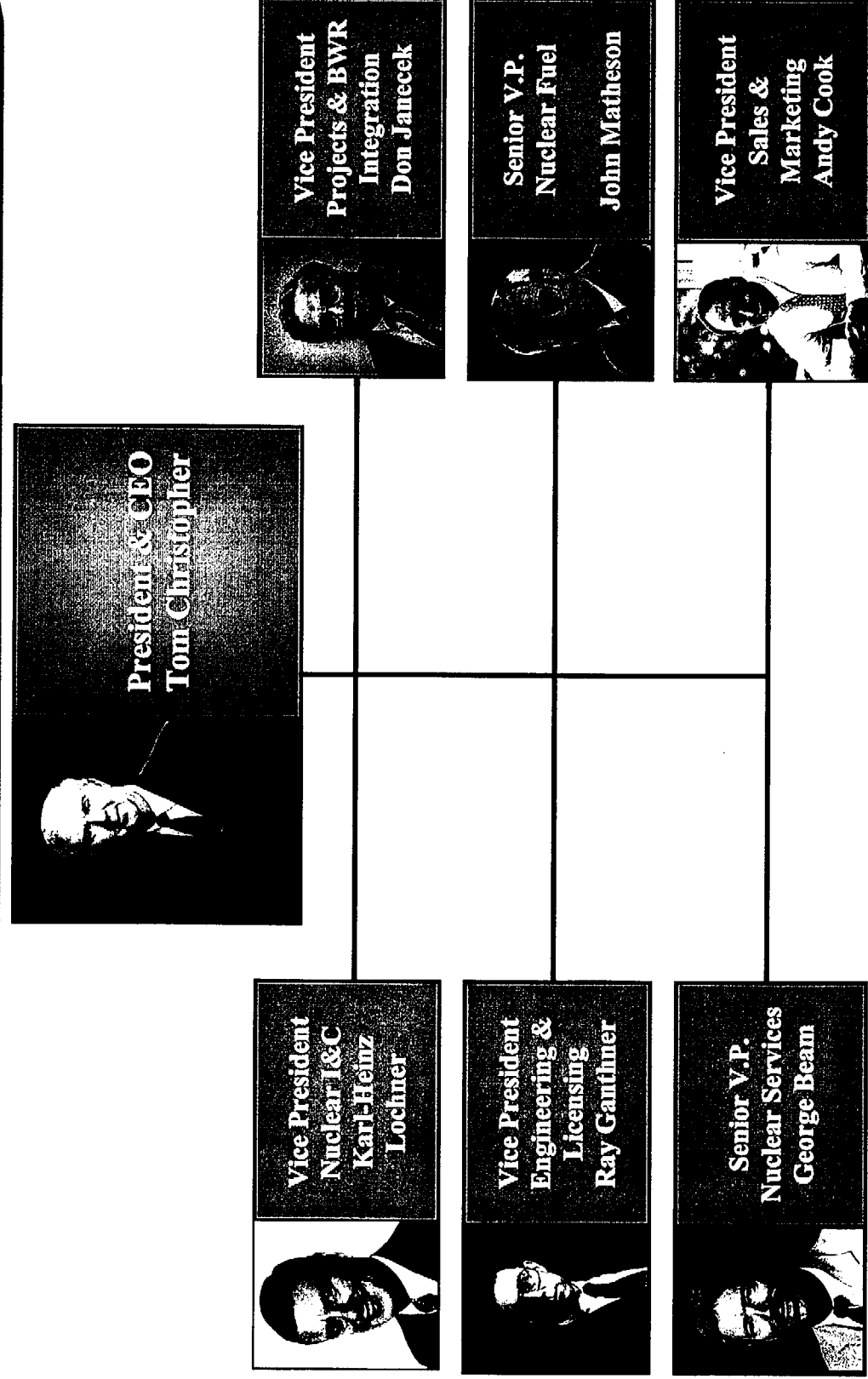


# Framatome ANP in the U.S.





# U.S. Organization



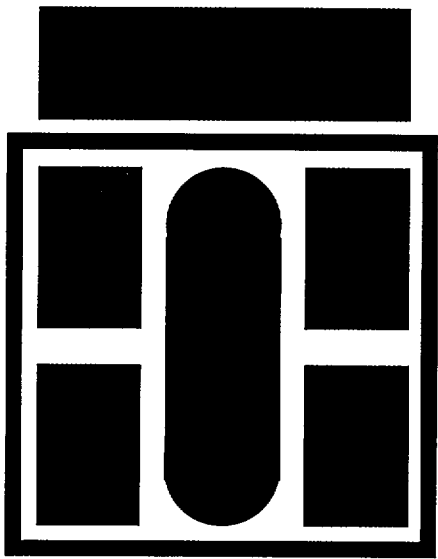
Framatome ANP



FRAMATOME ANP

# SWR 1000

## Framatome ANP's Boiling Water Reactor Concept

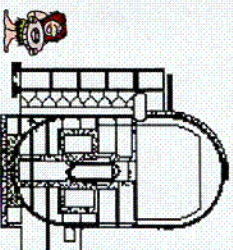


FRAMATOME ANP



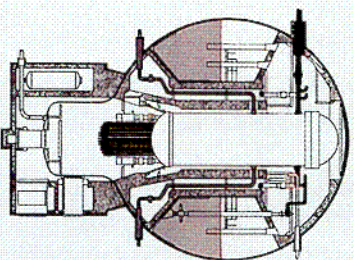
# Evolution of Framatome ANP's BWR Technology

- Kahl
- Gundremmingen A
- Lingen



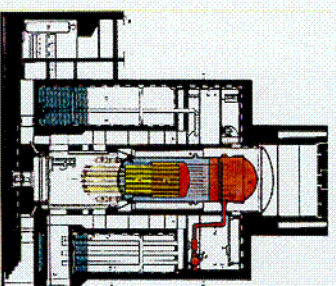
Full pressure  
containment - 61

- Würgassen
- Brunsbüttel
- Philippsburg 1
- Isar 1
- Tullnerfeld
- Krümmel

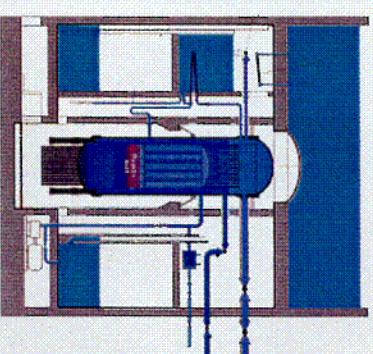


Product Line 69

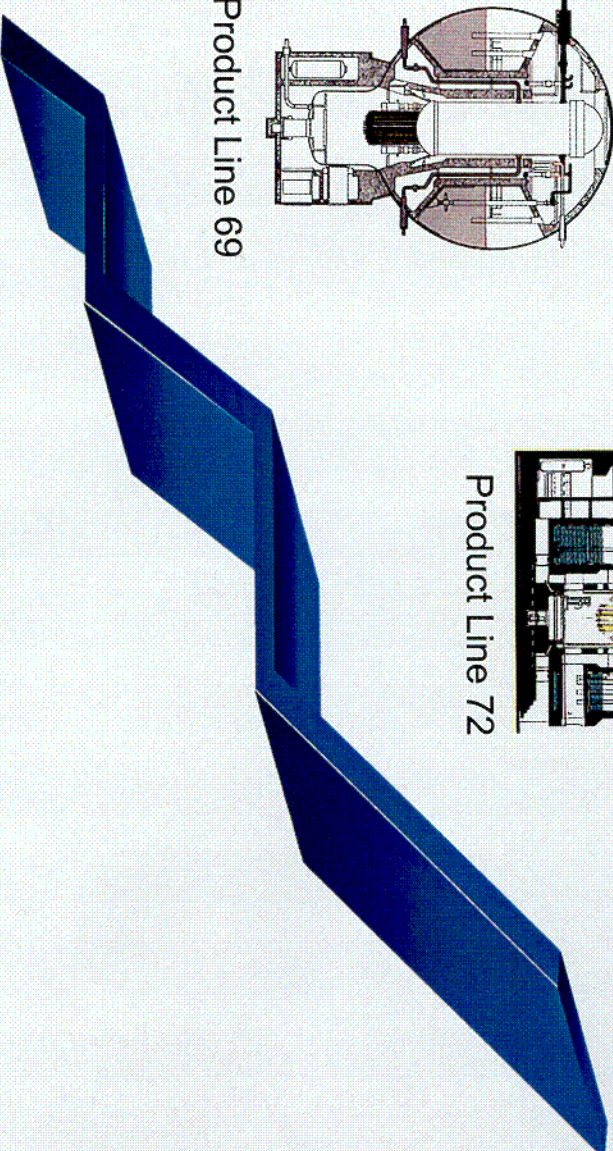
- Gundremmingen B/C



Product Line 72



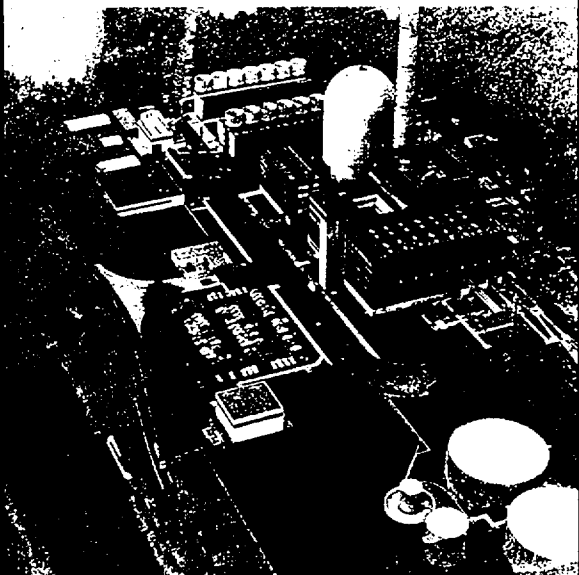
SWR 1000





# History of Framatome ANP's BWR Development

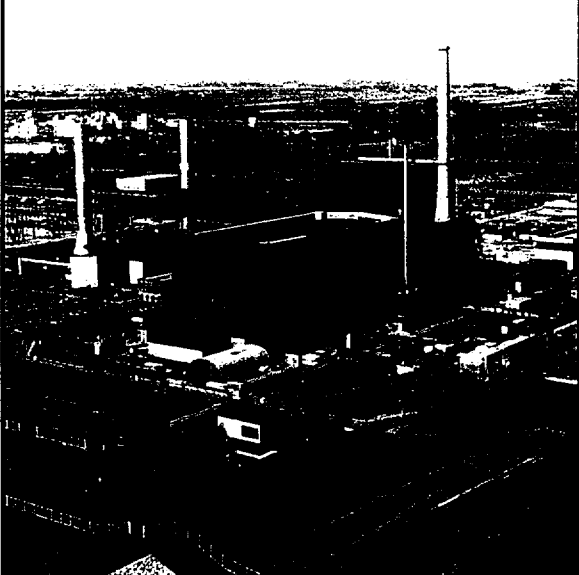
1968



**Lingen**

- The first FMCRD (Fine Motion Control Rod Drive)

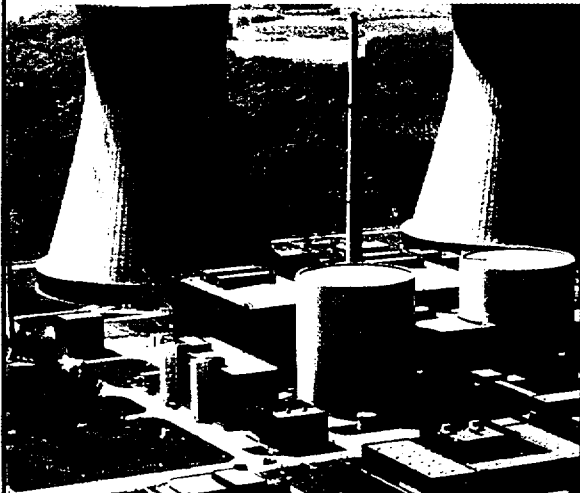
1977



**Brunsbüttel**

- The first internal recirculation pump

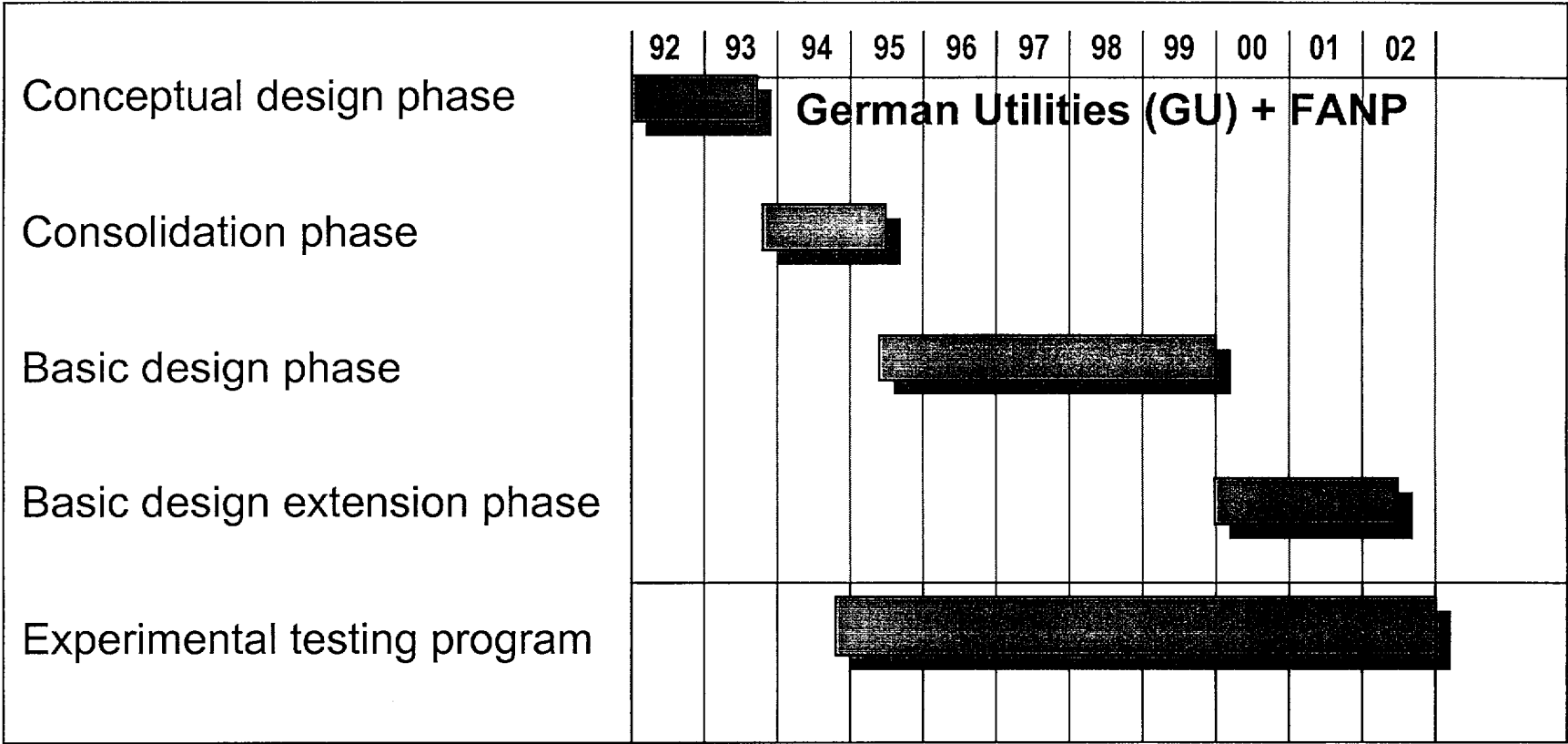
1984/85



**Gundremmingen B and C**

- FMCRD
- Internal recirculation pumps
- Three train full-range RHR system
- Cylindrical prestressed concrete containment

# Project History - SWR 1000 Development



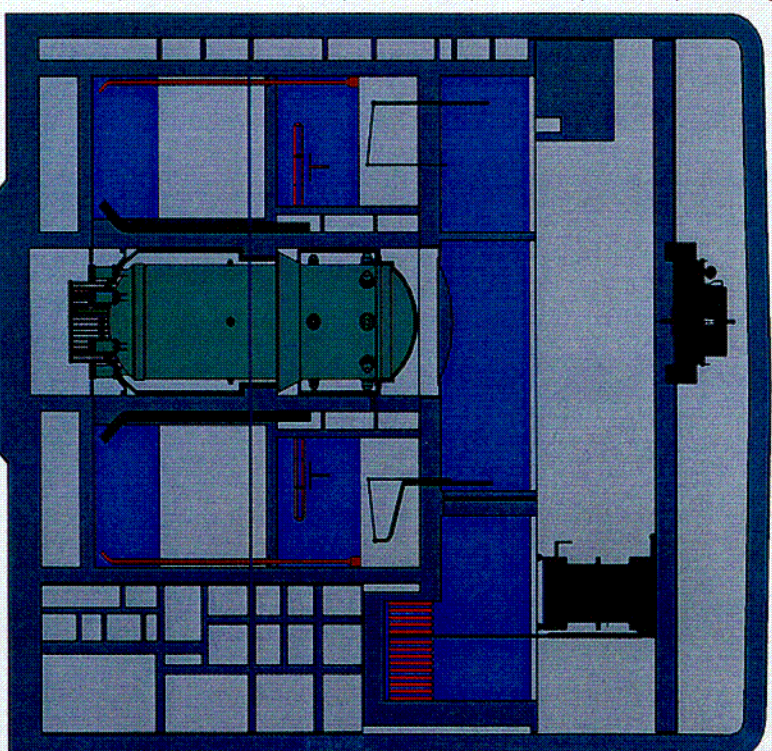


# Major Development Objectives

## Improved Safety

## Economic Feasibility

Thermal power	2,778	MW
Gross power output	~1,000	MW
Reactor Pressure	70.6 bar (1010 psig)	
Type of fuel assemblies	ATRUM 12	
Number of fuel assemblies	624	
Number of control rods	145	
Length of active core	2.8 m. (9.2 ft.)	
Max. accident pressure of containment	7.5 bar (95 psig)	



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# Improved Safety Objective

## Safety

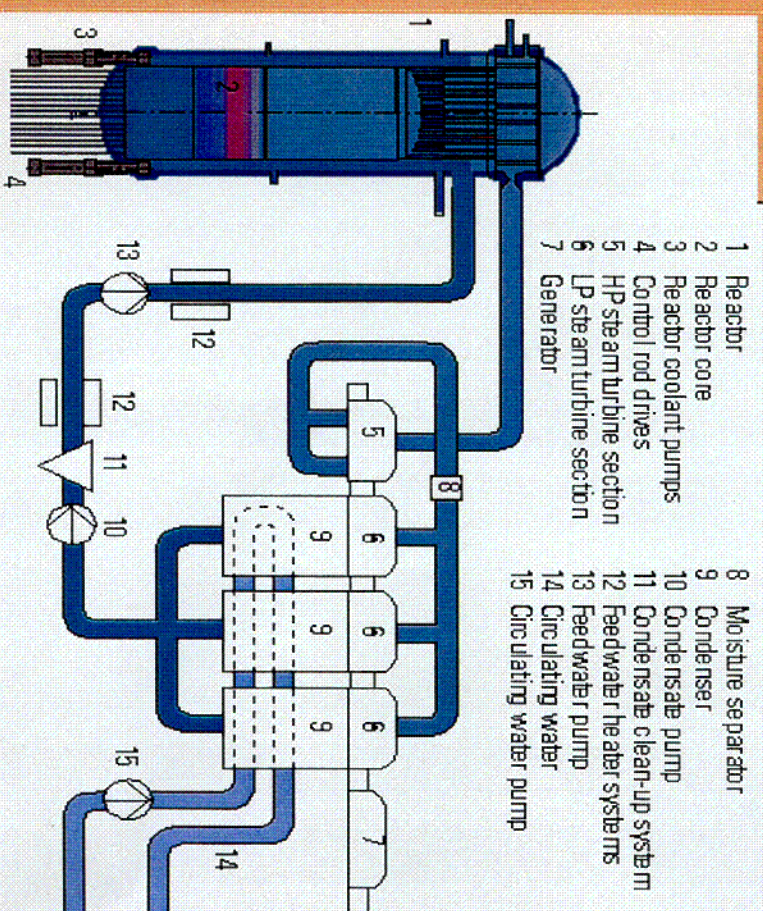
- Clear and simple system design
- Increased safety margins
- Reduction of core damage frequency
- Limiting the effects of core melt accident to plant itself
- Passive safety systems (Diversity and redundancy)
- Minimization of human error impact
- Grace period (> 3 days)



# Improved Economic Objective

## Operation & Economics

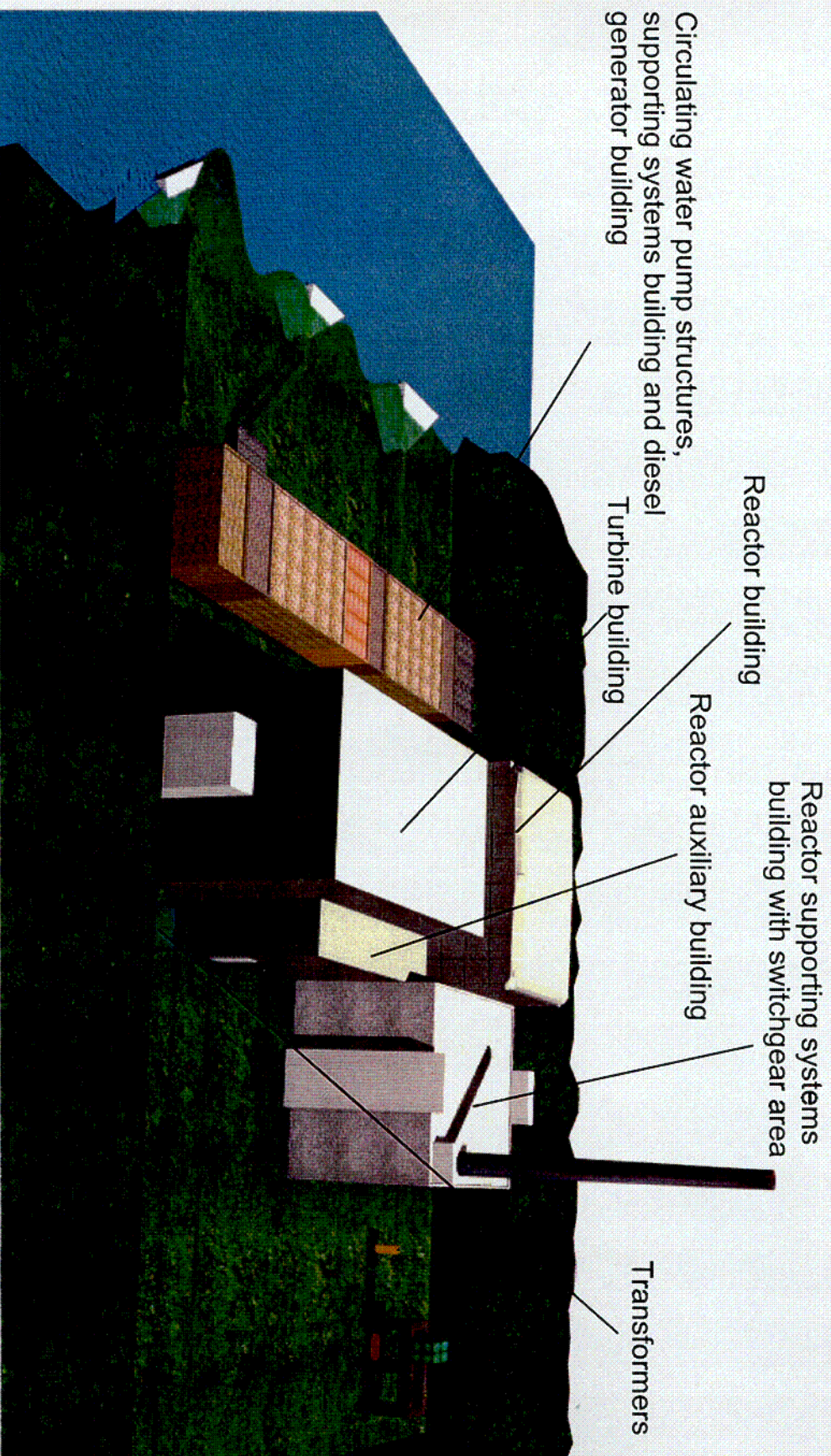
- Use of existing technology
- High plant availability
- Low maintenance
- Flexible fuel cycle length (12 to 24 m)
- High fuel burn-up (65 GWd/t)
- Reduction of process waste
- Design life of 60 years
- Competitive power production cost



Basic Diagram of SWR 1000



# Typical Plant Site Layout





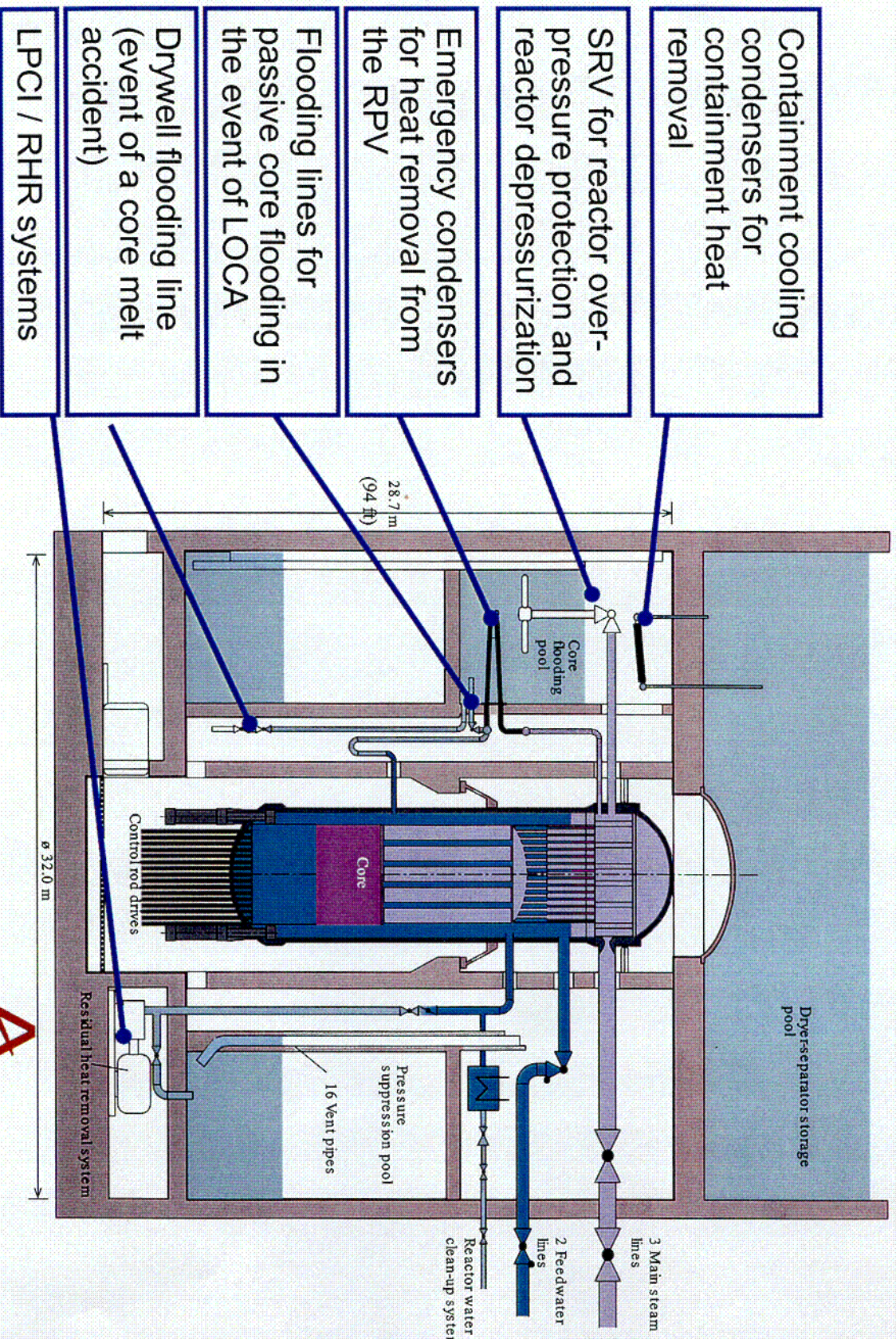
# SWR 1000 Design

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- ♦ All active systems have passive Safety Related backup to perform nuclear safety functions
- ♦ SWR 1000 Defense-in-Depth design incorporates Safety Related passive systems that are designed to meet all nuclear safety criteria without reliance on active systems



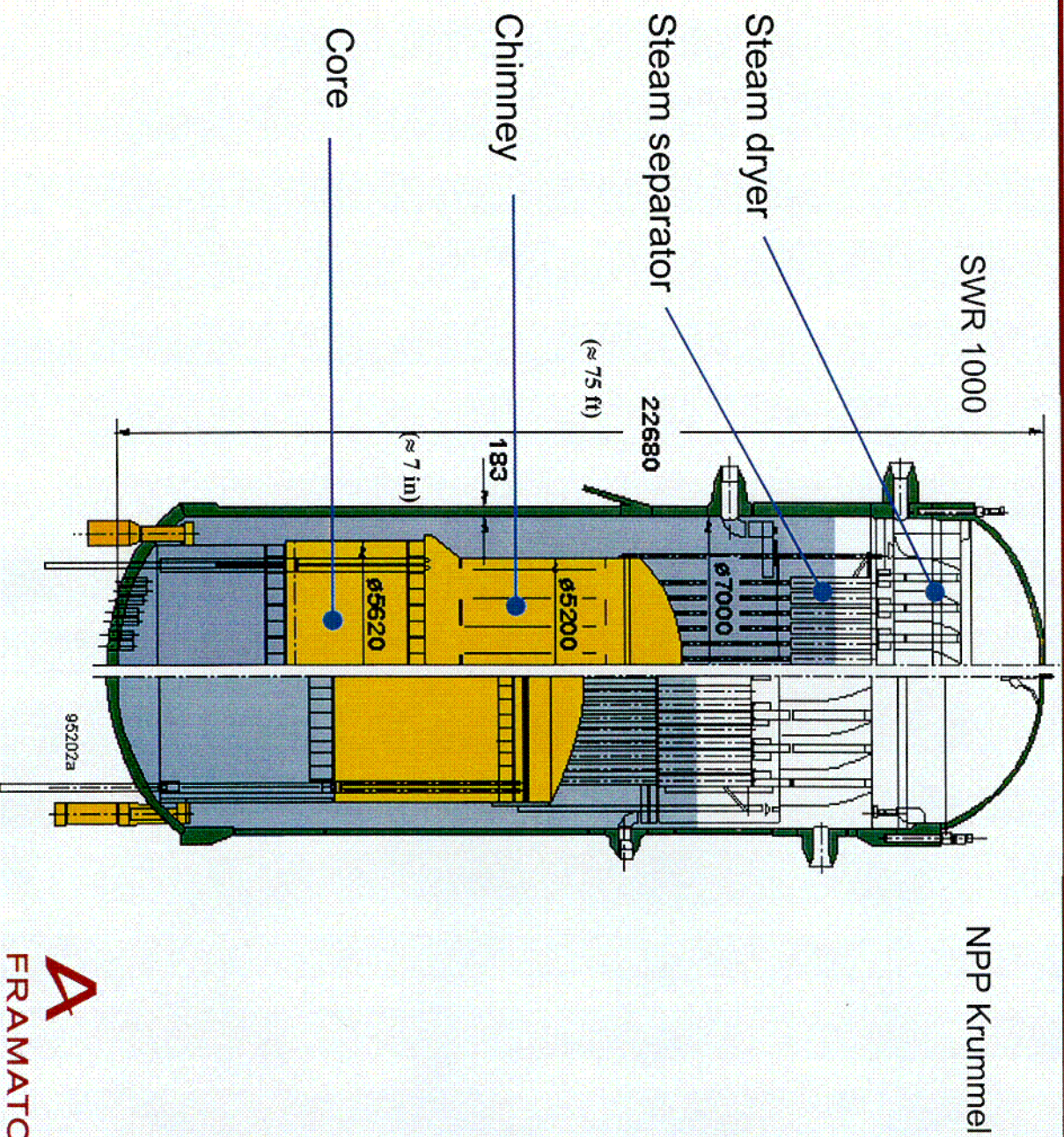
# SWR 1000 Safety Concept



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# RPV Comparison: SWR 1000 & NPP Krümmel



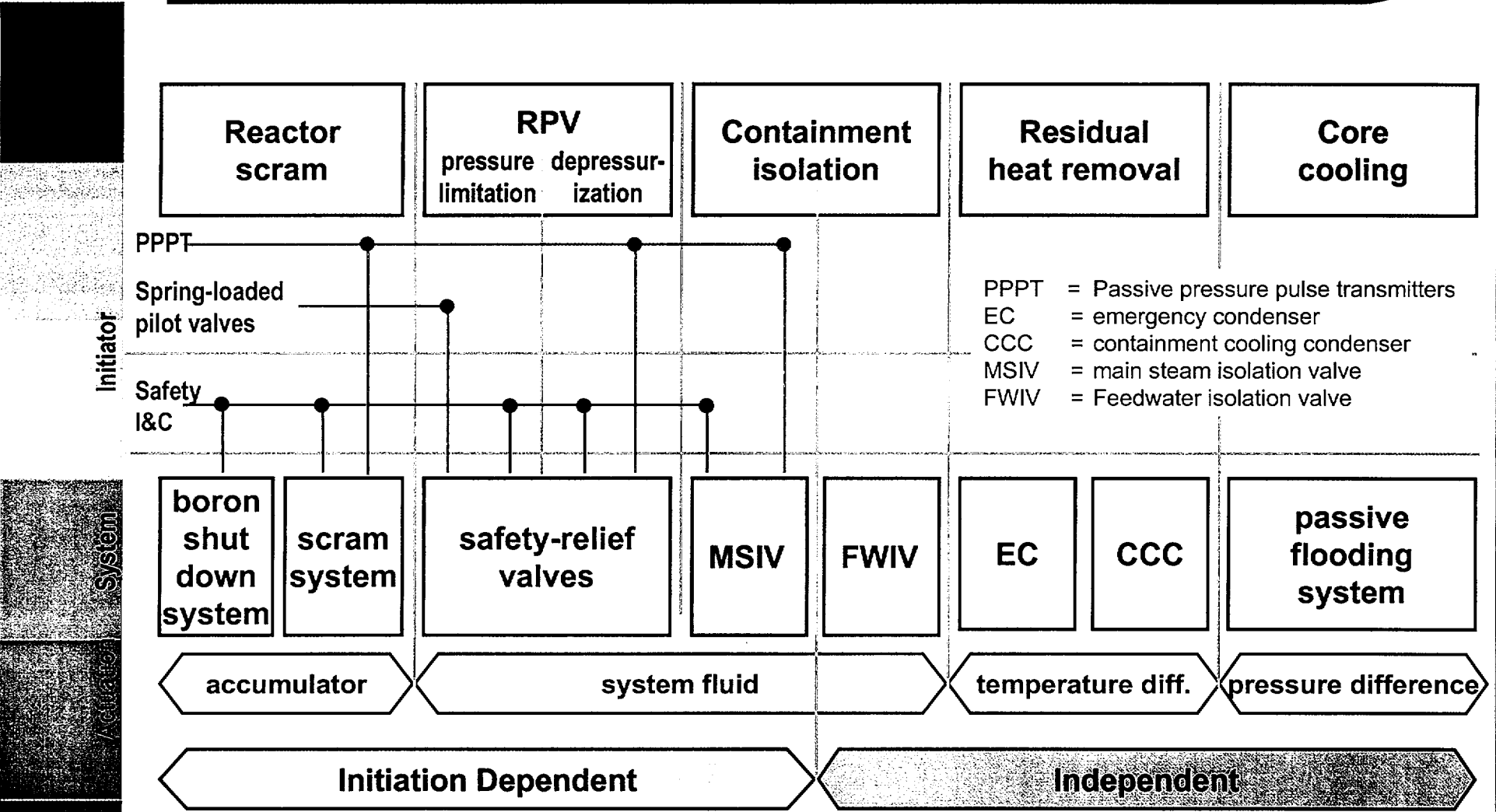
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# Defense in Depth Safety Concept

Safety Levels	Previous Nuclear Plants	SWR 1000
1st level	High-quality design, construction and operation to prevent off-normal operating conditions and accidents	Maintained
2nd level	Reliable control and limitation equipment for preventing off-normal operating conditions from developing into accidents	Proven technology utilized <b>Plus Lower core power density, and Large water volume in RPV</b>
3rd level	Safety systems for accident control and limitation of fuel cladding damage	Proven technology partially utilized <b>Plus</b> <ul style="list-style-type: none"><li>■ Diverse passive system for activation of safety systems</li><li>■ Passive safety systems</li><li>■ Large water reservoirs for long grace period</li></ul>
4th level	Beyond DBA	Equipment and provisions for control of a core melt accident so that <b>NO</b> offsite emergency response actions are necessary

# Passive Safety Systems

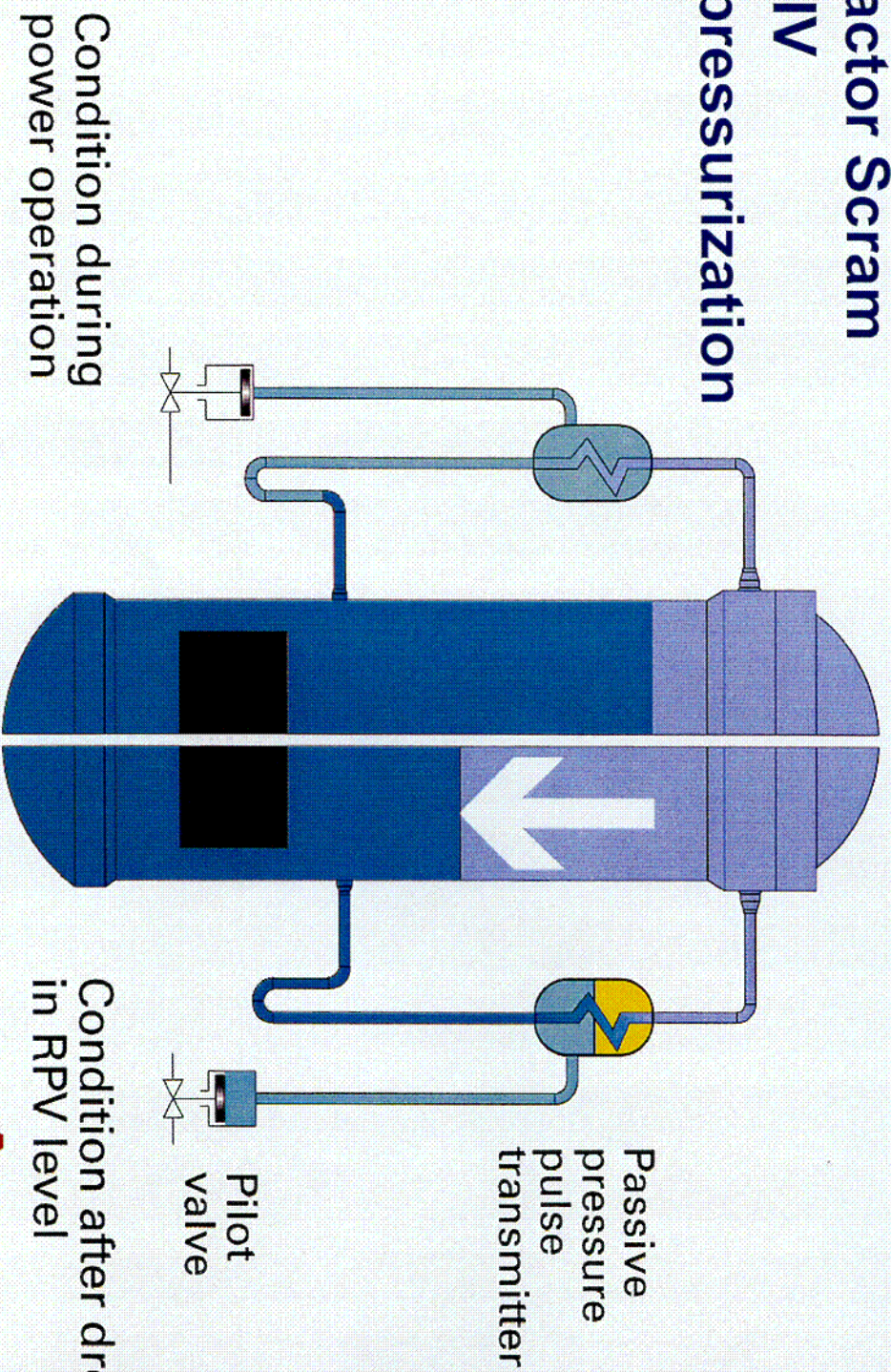




# Passive Pressure Pulse Transmitter: Passive Safety System Actuation Device (Patented)

PPPT actuates

- Reactor Scram
- MSIV
- Depressurization



Condition during power operation

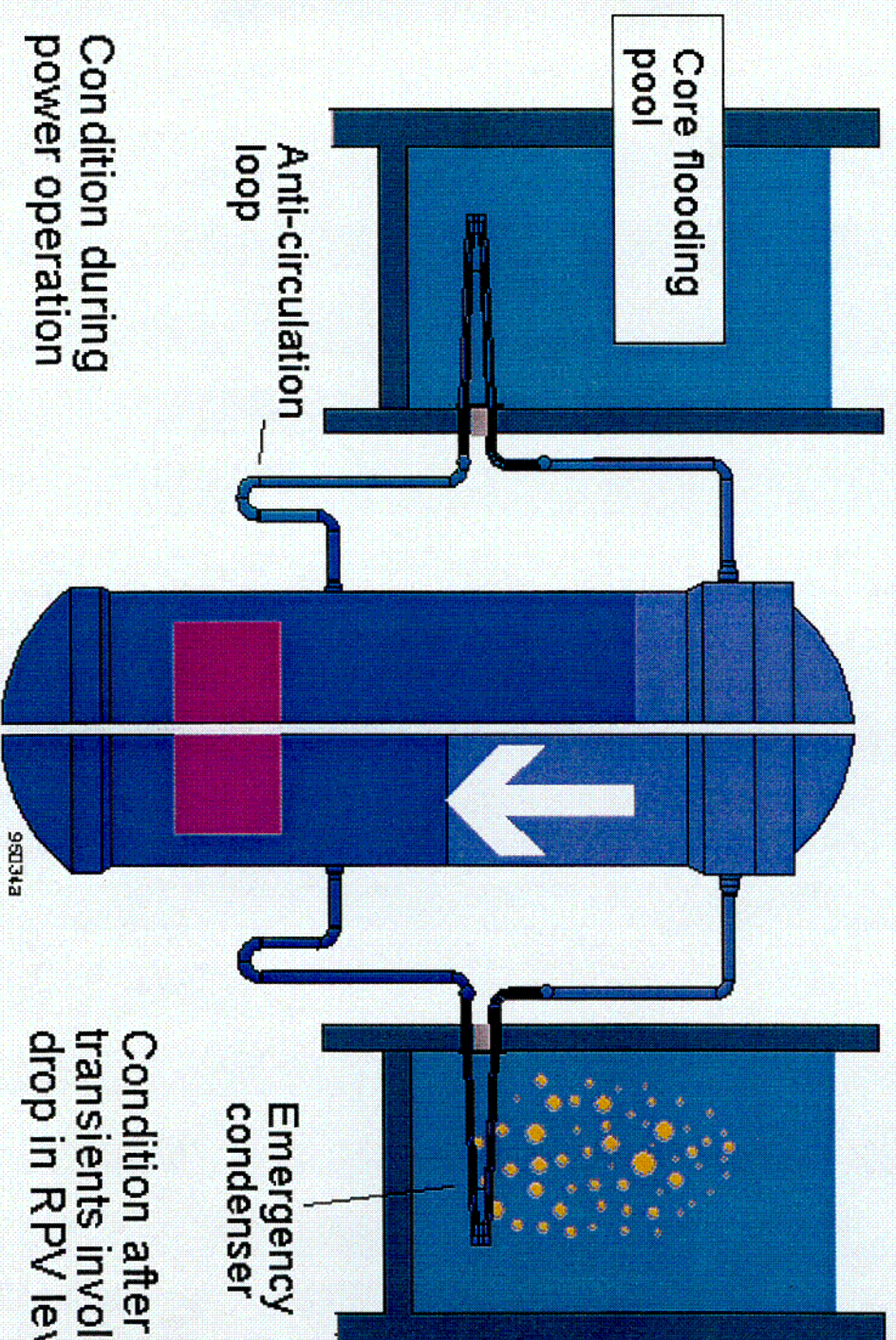
Condition after drop in RPV level



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# Passive Safety Systems: Emergency Condenser



Condition during  
power operation

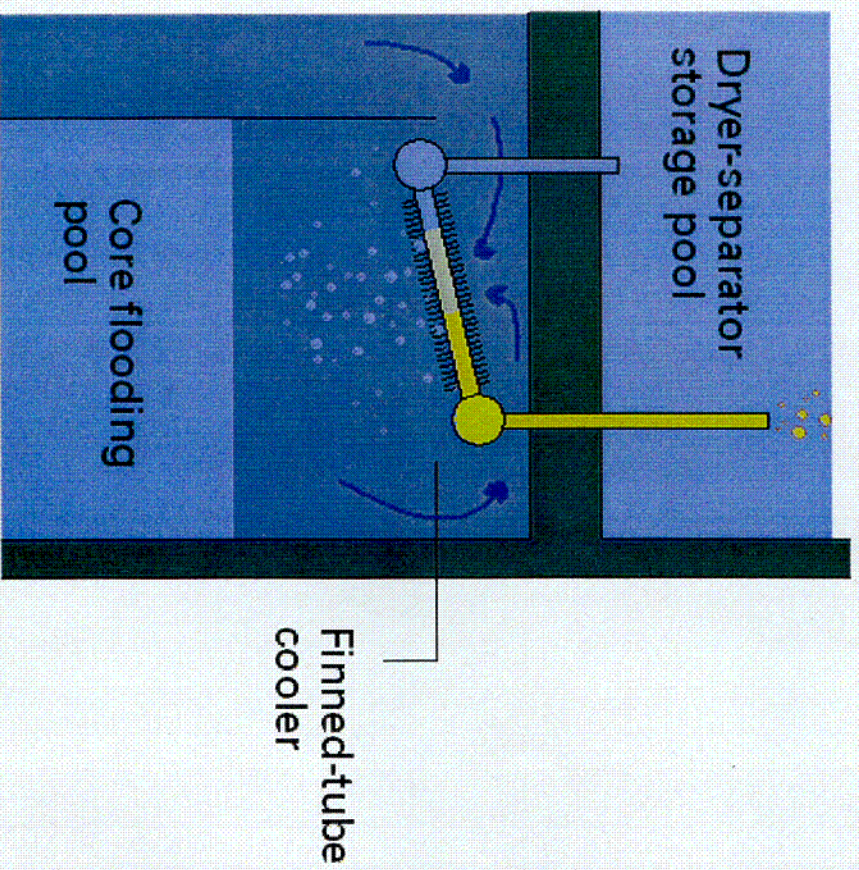
Condition after  
transients involving  
drop in RPV level



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# Passive Safety Systems: Containment Cooling Condenser



Containment Cooling Condenser



# LOCA Events Core Flooding Redundancy

SF ... Single failure CF ... Conseq. failure	Active Systems		Passive Systems				Effective Capacity
Core flooding upon LOCA	2 RHR/LPCI systems		4 Flooding lines				
	100%	100%	100%	100%	100%	100%	
Feedwater line break	CF	Maintenance	SF	✓	✓	✓	300%
Core flooding line break	Maintenance	SF	CF	✓	✓	✓	300%
	Maintenance	✓	CF	SF	✓	✓	300%
Leak below core (15 cm <sup>2</sup> )	Maintenance	SF	50%	50%	50%	50%	200%

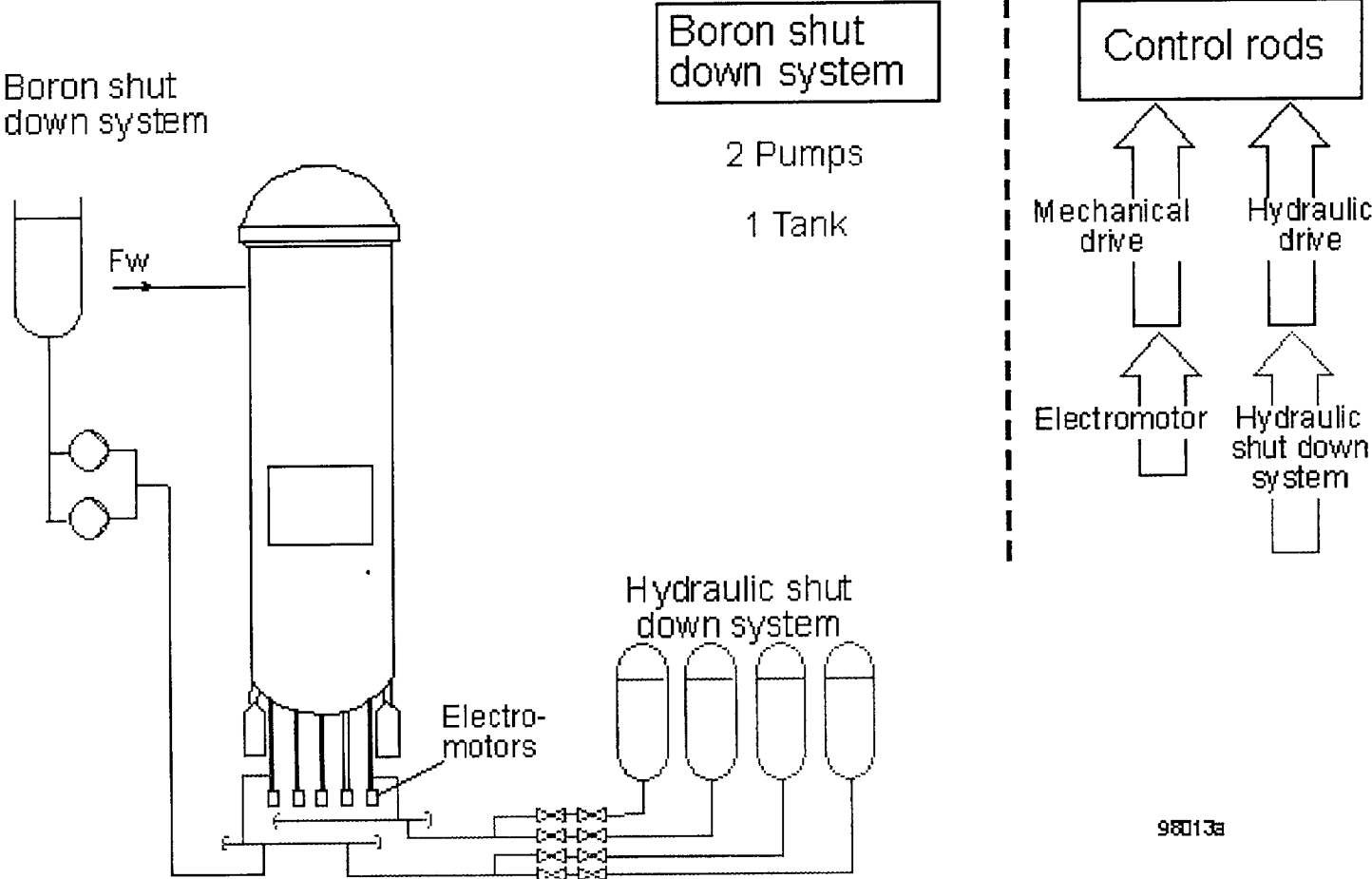
200 - 300% Core Flooding Capacity without Active Systems and one Core Flood Line Unavailable

# Containment Heat Removal Capacities

SF ... Single failure	Active Systems		Passive Systems				Effective Capacity
Heat removal from containment	2 RHR systems		4 containment cooling condensers				
	100%	100%	50%	50%	50%	50%	
Failure assumptions	SF	Maintenance	✓	✓	✓	✓	200%

200% Containment Heat Removal Capacity  
without Active Systems

# Diverse Shut Down Systems



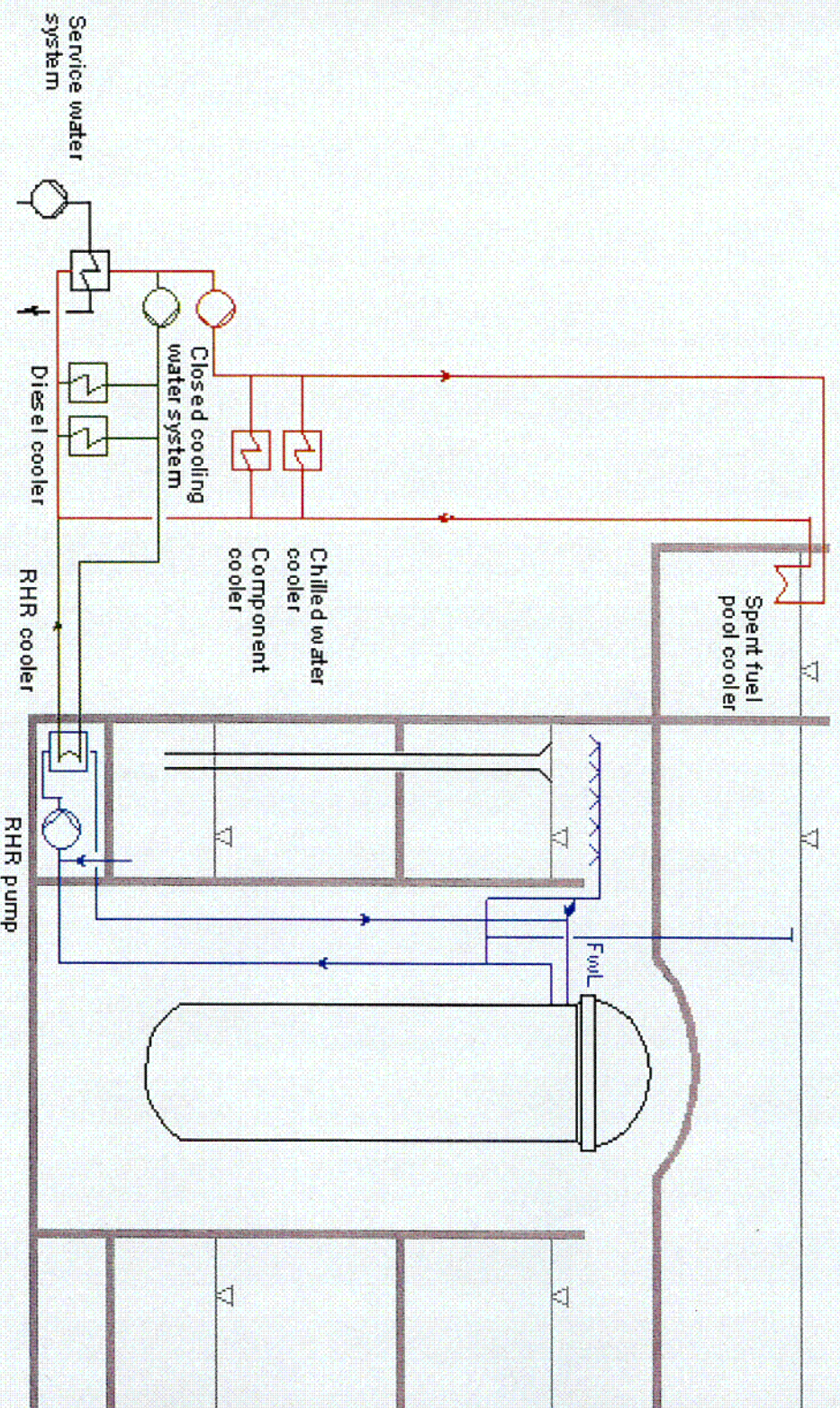
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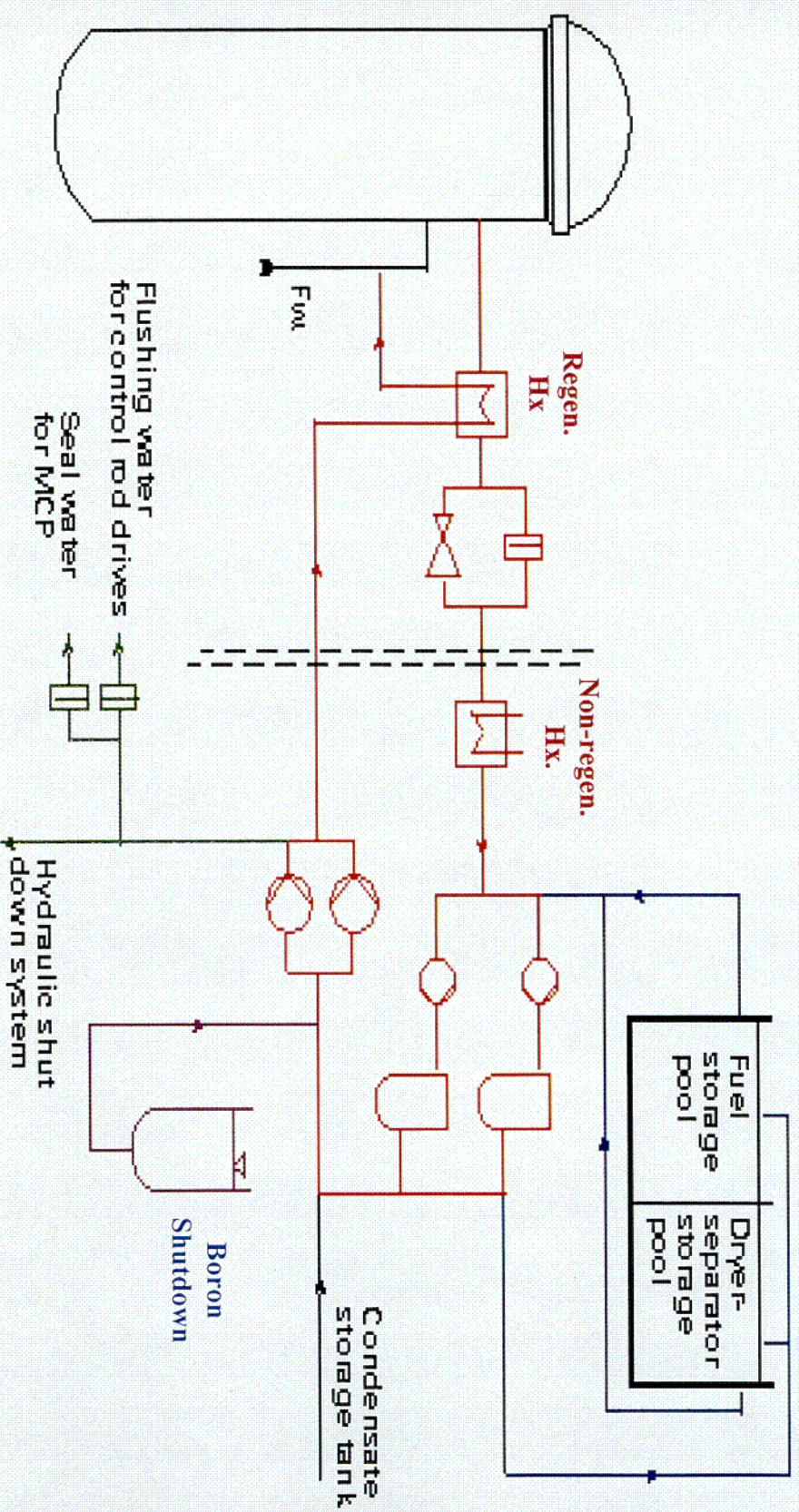


# LPCI/Residual Heat Removal Systems



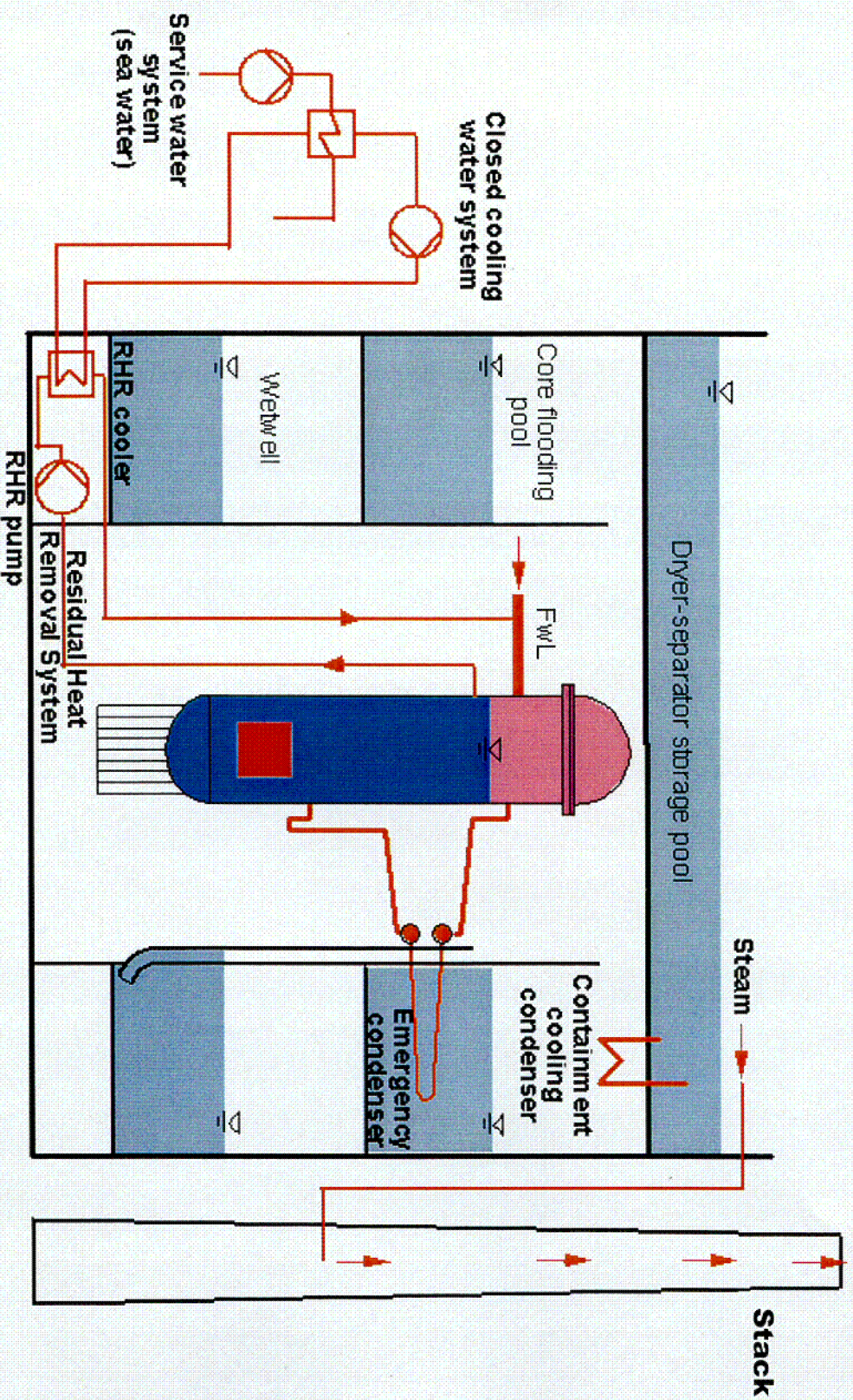


# Reactor Water and Fuel Storage Pool Clean-Up Systems





# Residual Heat Removal Heat Sink Diversity





# SWR 1000 - Severe Accident Control Core-Melt Retention in the RPV

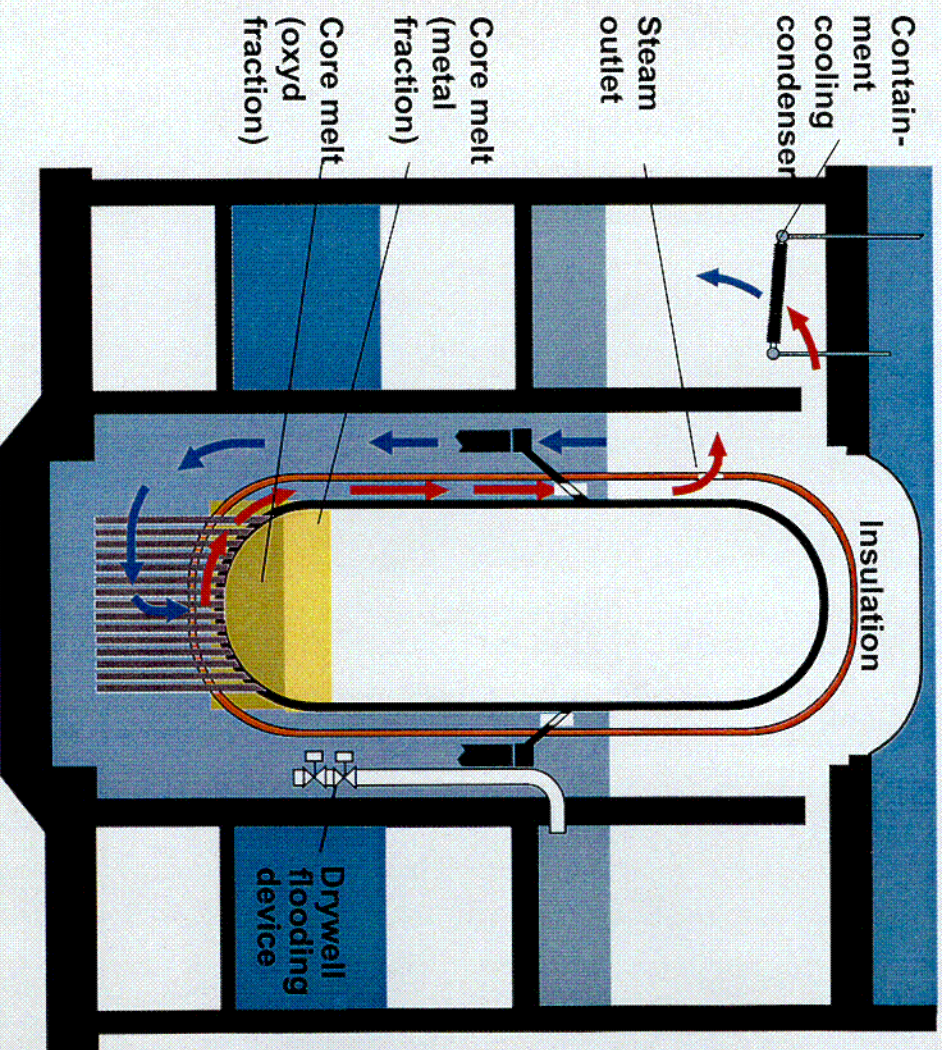
External cooling of Reactor Pressure Vessel (RPV)

Inerted containment

Max. Containment pressure 95 psig (100% zirc-water)

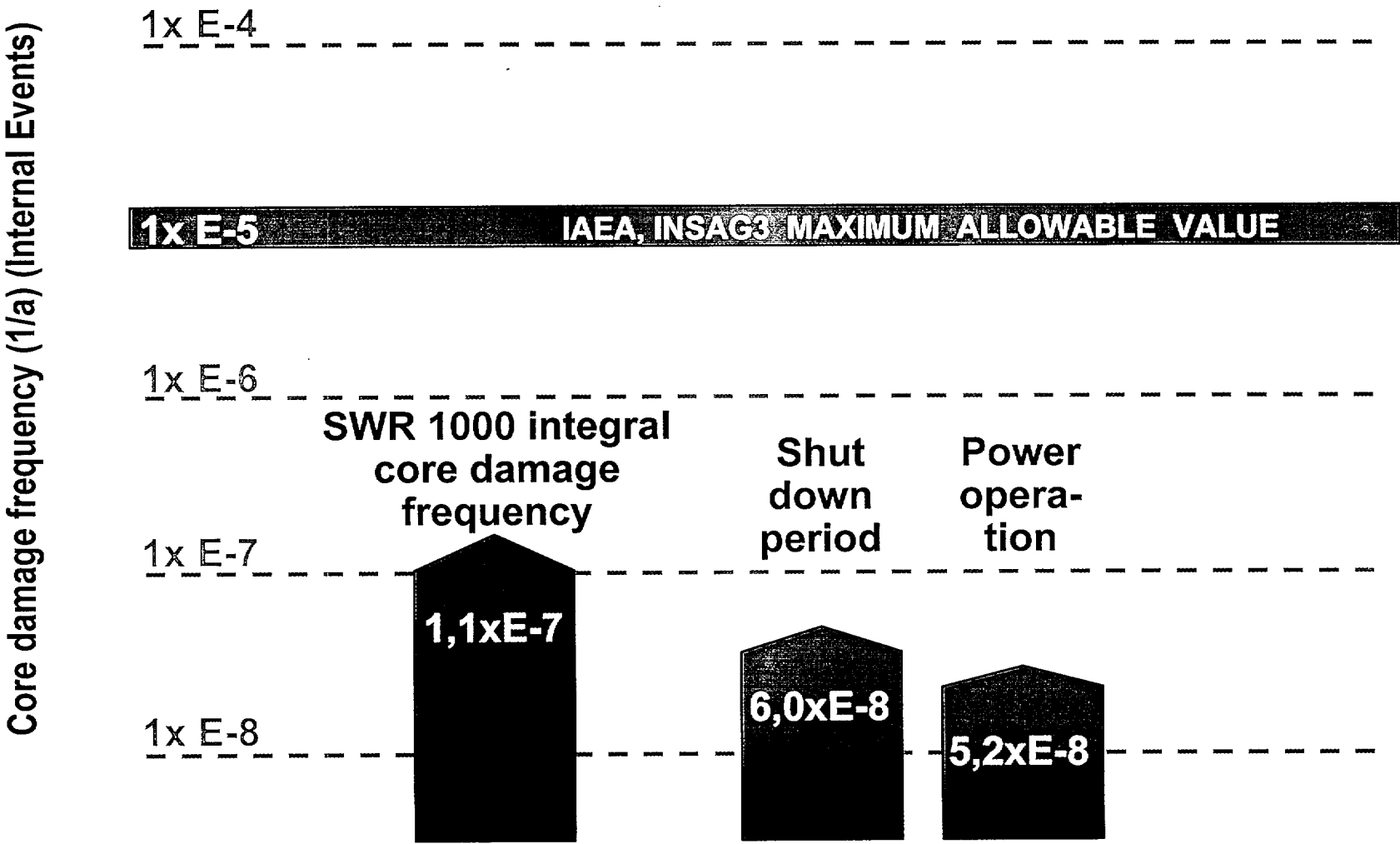
Passive heat removal from containment

Containment vent to condenser off-gas



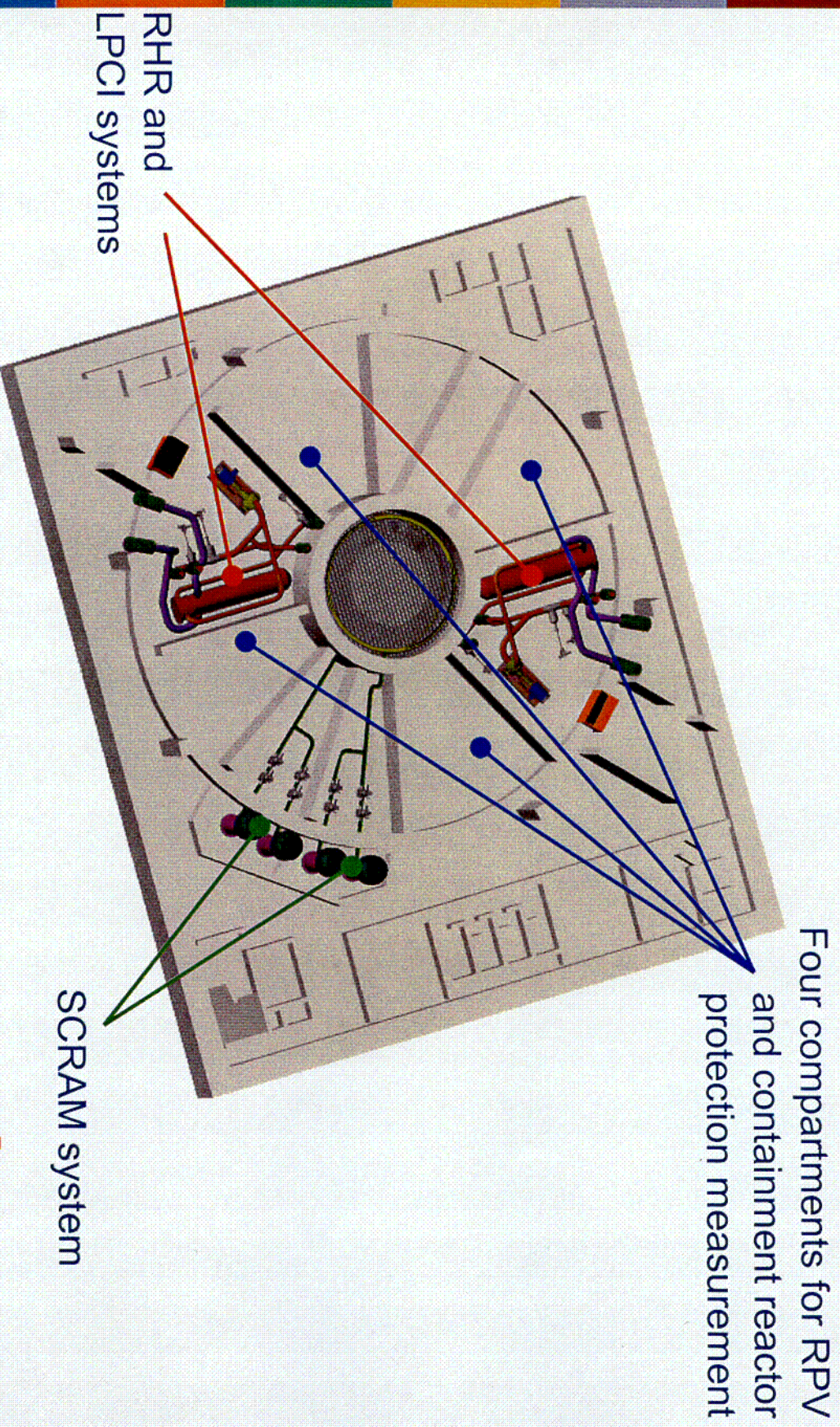


# Probabilistic Safety Assessment



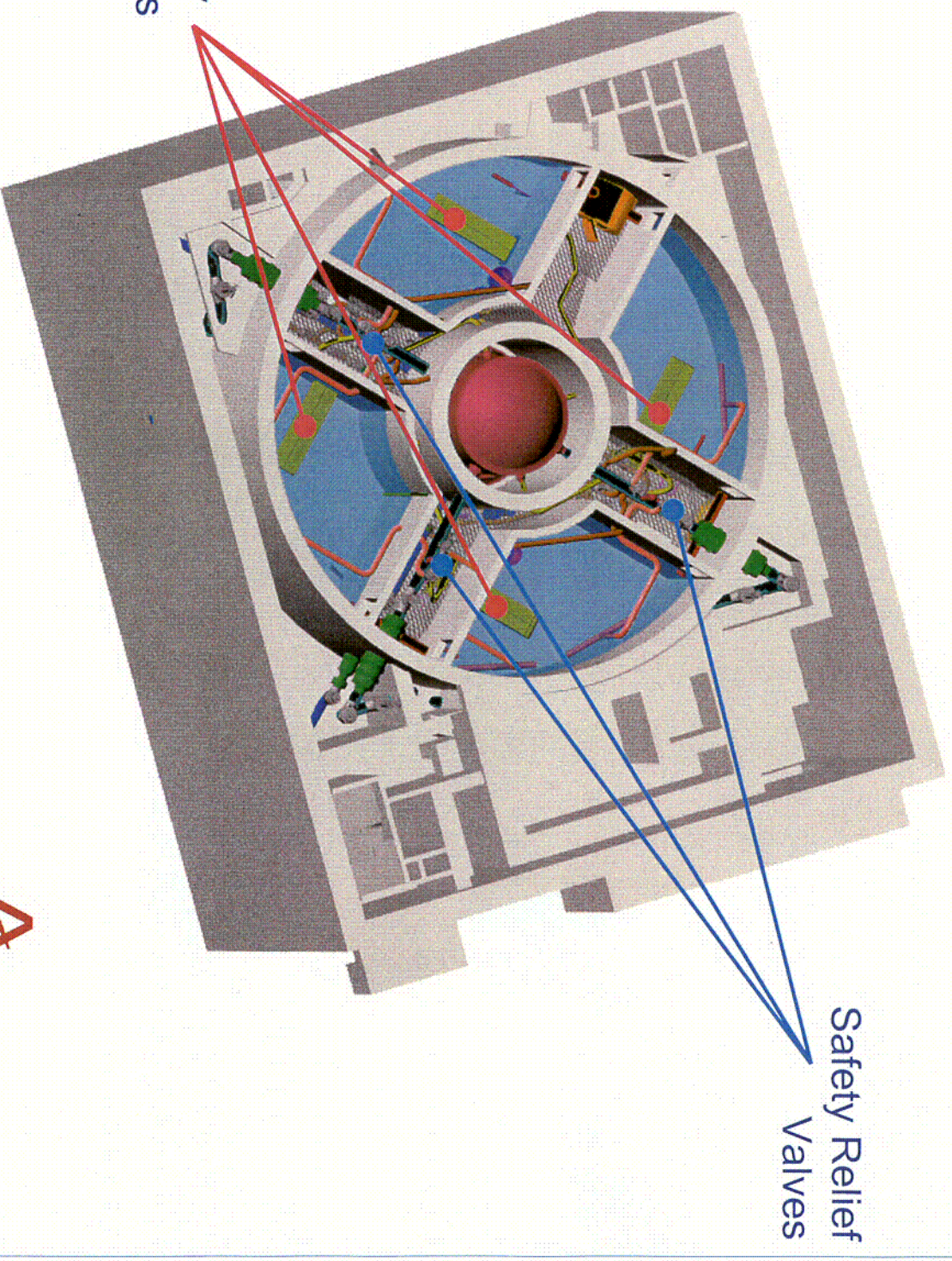


# Physical Separation of Safety Systems





# Physical Separation of Safety Systems



Emergency  
Condensers

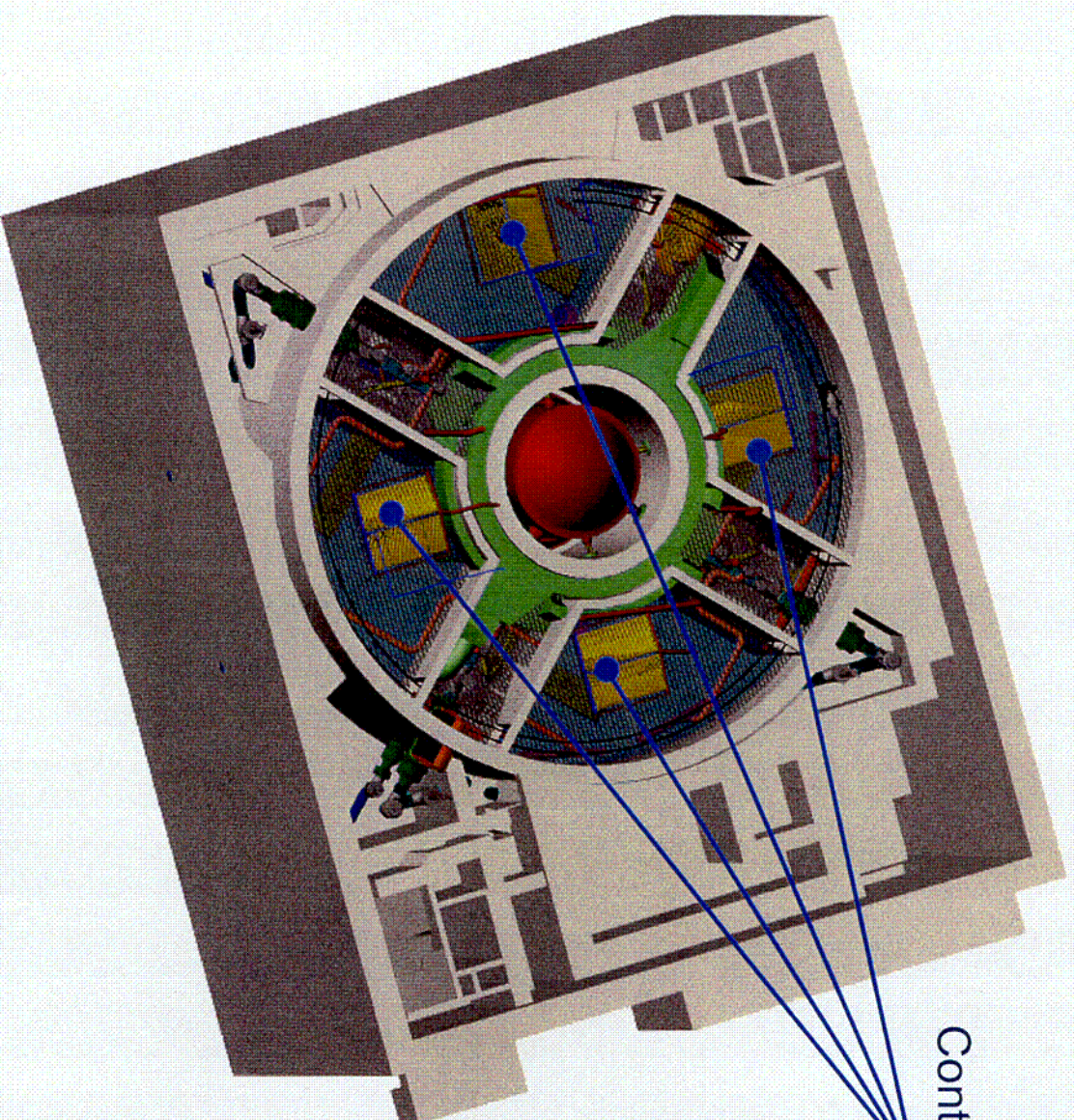
Safety Relief  
Valves

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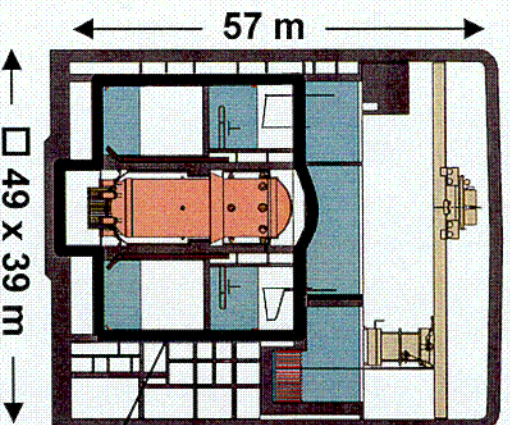
# Physical Separation of Safety Systems



Containment Cooling  
Condensers



# SWR 1000 Reactor Building and Containment



## Reactor building

Designed against external loads

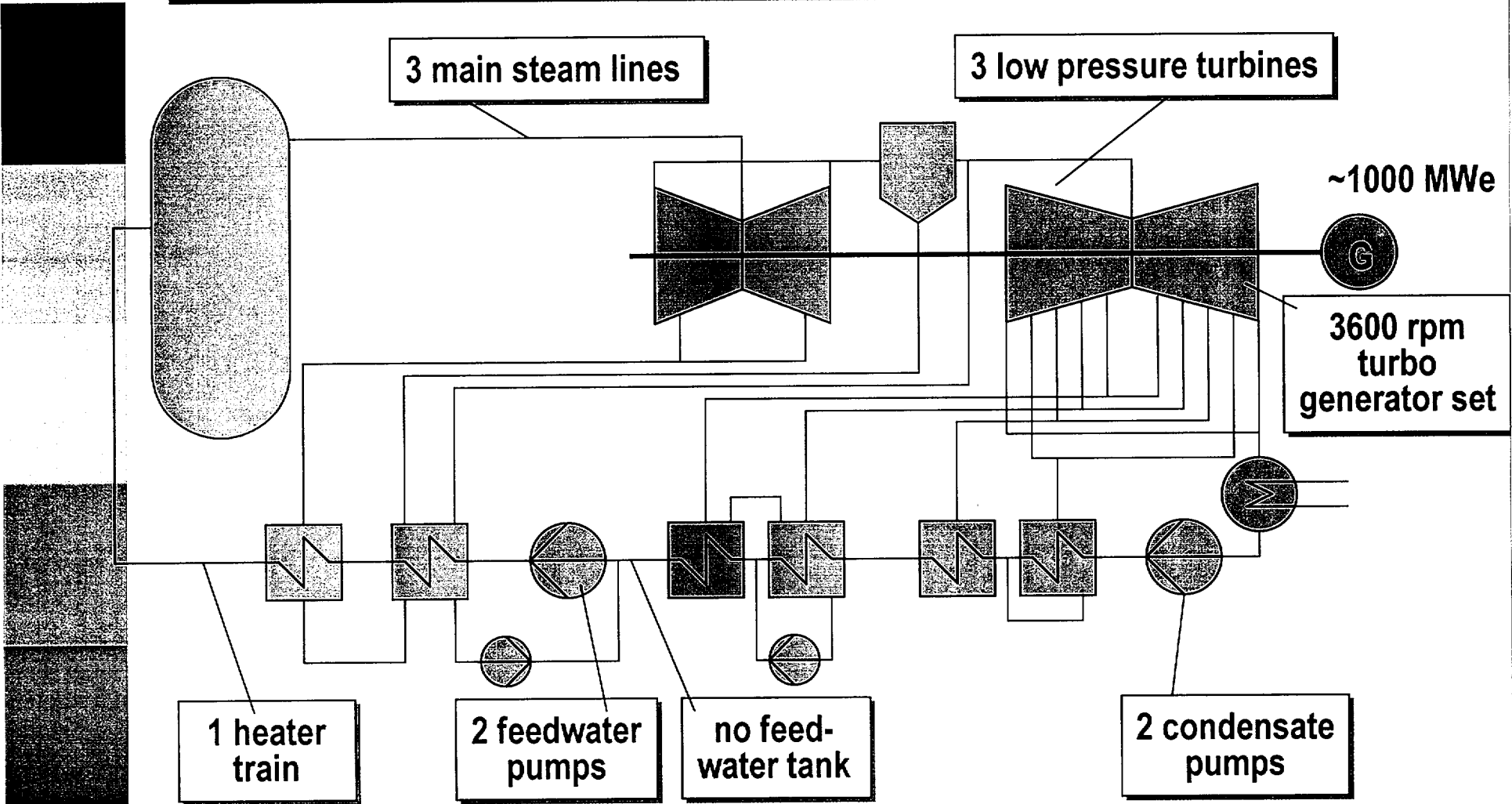
- Earthquake
- Military airplane crash
- Explosion pressure wave

## Containment

- Reinforced concrete with steel liner, designed against severe accident pressure (7.5bar, 95psig)
- Inert (nitrogen) atmosphere during operation



# Steam, Condensate and Feedwater Cycle





# Simplified Systems Design

System Type	SWR 1000	1100 MW <sub>e</sub> BWR
Emergency condenser	-	-
HPCI-system	-	3 x 100%
Spent fuel pool cooling system	Cooler inside fuel pool	3 x 100%
LPCI-system	2 x 100%	3 x 100%
Reactor water cleanup system	-	2 x 100%
MCP-sealwater system	2 x 100%	3 x 100%
CRD-purging system	combined system	2 x 100%
Boron injection system	-	2 x 100%
Main steam lines	3	4
Feedwater lines	1/2	2/4
Feedwater heater train	single train	double train
Electrical- / I&C-system	double train (+ passive systems)	3 trains



# Current Status

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- Basic design has been completed
- A preliminary safety analysis report has been completed
- The new passive safety systems features have been tested, other testing continues
- The SWR 1000 is one of the innovative options being considered for a 5th unit in Finland



# SWR 1000 Design

- ♦ All active systems have passive Safety Related backup to perform nuclear safety functions
- ♦ SWR 1000 Defense-in-Depth design incorporates Safety Related passive systems that are designed to meet all nuclear safety criteria without reliance on active systems
- ♦ Framatome ANP believes the SWR 1000 is an Evolutionary BWR design



# Specific Objectives

- ◆ **We Seek Clear Policy Statements on the Following:**
  - ◆ NRC position on the application of PRA and its relationship to Regulatory Treatment of Non-Safety Systems
  - ◆ NRC position on the treatment of potential reactor vessel failure
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