EXPOPOWER Fair 2018 in Poznan, Poland

Major Characteristics of EU-APR

Apr. 23, 2018

ICHNP

CONTENTS

1 Introduction

1. Introduction (1/4)

- APR1400, the reference plant
  - Evolutionary Type ALWR based on OPR1000 and System 80+
  - Standard Design Certificate (May 2002) after 10 Years of Development

	Under Construction	Operating
Domestic	SKN #4(Aug. 2009 ~) , SUN #1,2(Jul. 2012 ~) SKN #5,6(Apr. 2017 ~)	SKN #3(Dec. 2016 ~)
Oversea	BNPP #1,2 (Jul. 2012 ~), #3,4 (Sep. 2014 ~)	

1. Introduction (2/4)

- Design Criteria of APR1400
  - U.S. Regulations
    - ✓ U.S. 10 CFR 20 (Radiation), 50 (License), 100 (Site), etc.
    - ✓ U.S. NRC Regulatory Guides, Generic Letters, Bulletins
    - ✓ U.S. NRC Standard Review Plan, NUREG-0800
  - U.S. NRC Policy Issues
    - ✓ SECY-93-087
  - U.S. Codes & Standards
    - ✓ ANS (Safety Classification), ASME (Mechanics), ASTM (Material), ACI (Concrete), NEFA (Fire), IEEE (Electricity and Instrument), etc.

1. Introduction (3/4)

Safety Goals of APR1400

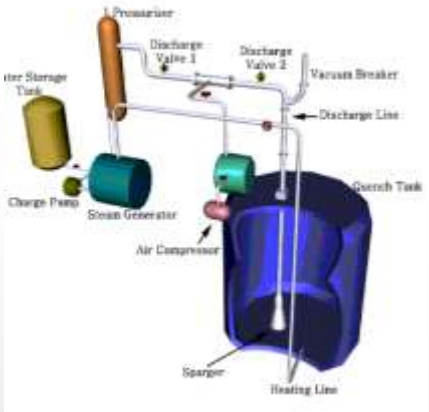
- Core Damage Frequency < 1.0×10^{-5} RY (Actual: 2.25×10^{-6} RY)
- Containment Failure Frequency < 1.0×10^{-6} RY (Actual: 2.84×10^{-7} RY)
- Seismic Design Basis: 0.3 g

Performance and Economy of APR1400

- Power: 1400 MWe (Net Electrical Output) / 4000 MWt (NSSS Capacity)
- Plant Lifetime: 60 years
- Refueling Cycle: 18 months with UO_2 fuel

1. Introduction (4/4)

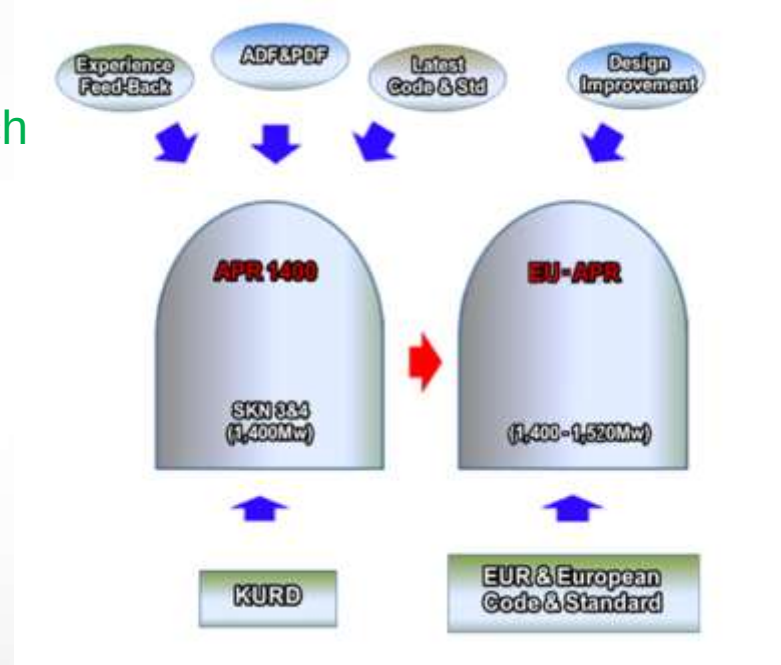
- Proven Design Features of APR1400
  - Direct Vessel Injection(DVI) with Emergency Cooling Barrel Duct(ECBD)
    - ✓ Eliminating the Safety Injection water spillage during LB LOCA in cold leg
  - Fluidic Device in Safety Injection Tank (SIT)
    - ✓ No need of LPSI pumps by regulating the SIT flow passively
  - In-Containment Refueling Water Storage Tank (IRWST)
  - Fully Digital Man-Machine Interface



2 Overview of EU-APR

2. Overview of EU-APR (1/3)

- What is EU-APR™?
  - Modified version of APR1400 to comply with European safety and performance requirements
    - ✓ Key design features of APR1400 + design improvements
- Design Philosophy of EU-APR
  - Enhanced Defense-in-Depth (DiD) Approach
  - Simplified Plant Design
  - Sufficient Design Margin
  - Proven Technology
  - Human Factors Engineering



2. Overview of EU-APR (3/3)

Comparison of APR1400 Series

Parameters		APR1400	EU-APR
Design Criteria Base		10CFR, NRC RG	**IAEA, WENRA, EUR**
Metrication		British	**SI**
Frequency		60 Hz	**50 Hz**
Codes & Stds	Mech.	ASME	**ASME, EN**
	Elec./I&C	IEEE	**IEC**
	QA	ASME NQA-1	**IAEA GSR Part2, ISO**
Acceptance Criterion for limiting DBC(LBLOCA)		250 mSv/2hr (TID-14844)	**5 mSv (RST)**
Redundancy of Safety Systems		Mech. 4-train Elec. 2-train	**Mech. 4-train** **Elec. 4-train**
Aircraft Crash Protection Design		Exclusion due to low APC Probability	**Double Containment, Reinforced Aux. Bldg**
Severe Accident Mitigation Systems		SAs Dedicated Sys. + DBC Mitigation Sys.	**Dedicated Systems for SAs**
I&C Architecture		2-platform	**3-platform**

2. Overview of EU-APR (2/3)

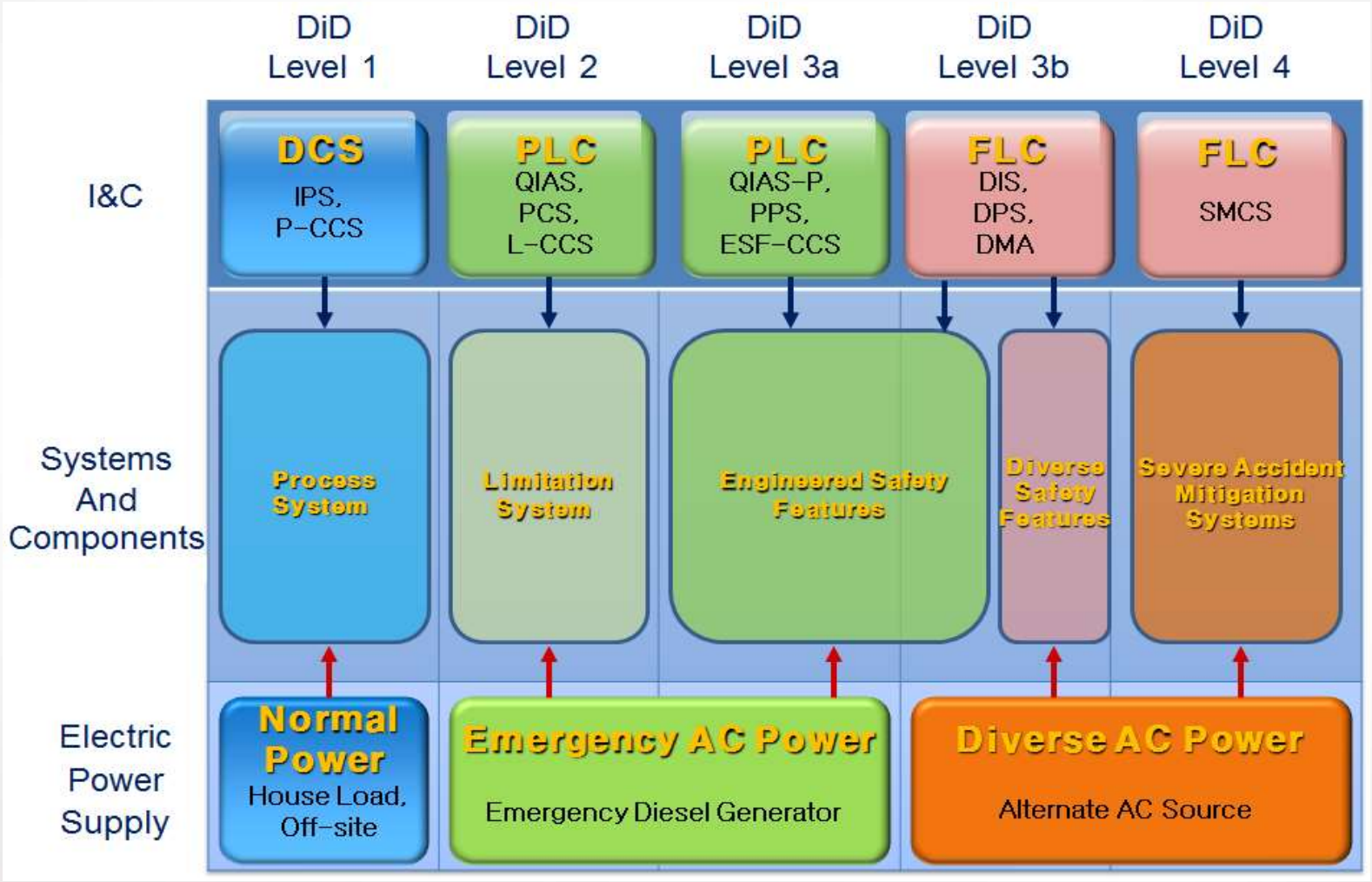
Functional DiD Concept

- WENRA RHWG, “Safety of New NPP Designs”, 2013

Level of DiD	Objective	Essential means
Level 1	Prevention of abnormal operation and failures	Conservative design and high quality
Level 2	Control of abnormal operation and failures	Control, limiting and protection systems and surveillance
Level 3	*Level 3a:* Control of Accidents within the Design Basis	Engineered Safety Features
	Level 3b: Control of Design Extension Conditions	Diverse (Additional) Safety Features
Level 4	Mitigation of Severe Accidents	Dedicated (Complementary) Safety Features
Level 5	Emergency preparedness	Off-site emergency response

2. Overview of EU-APR (3/4)

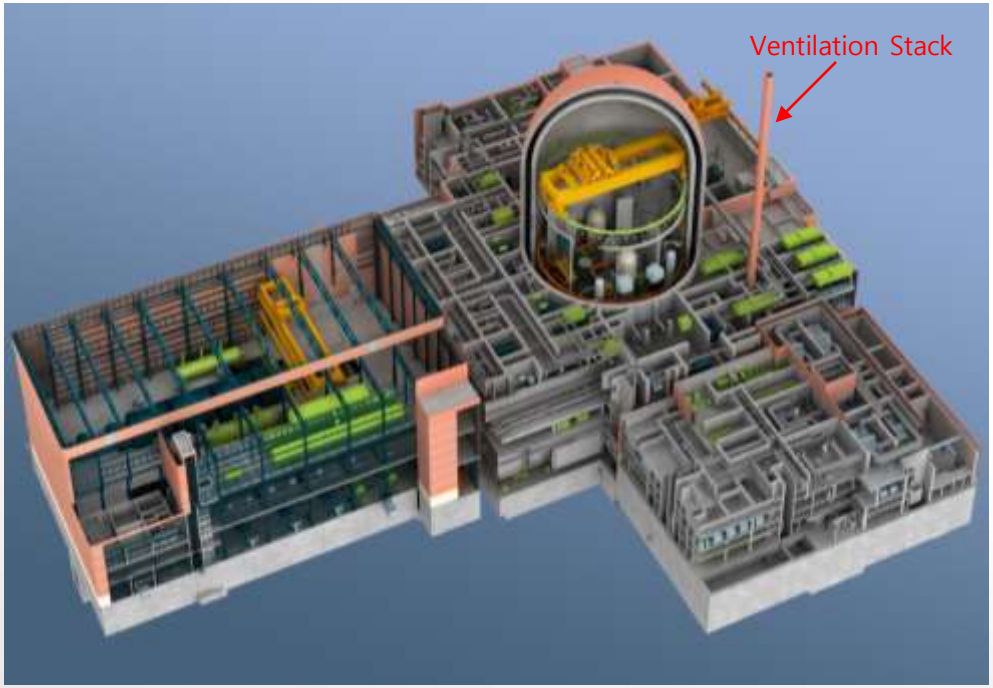
- System Architecture

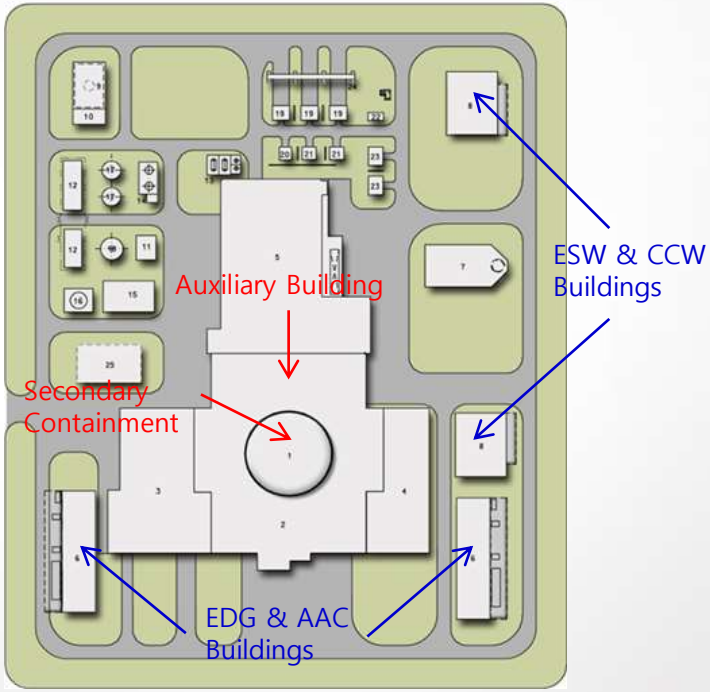


3 Major Advanced Design Features of EU- APR

3. Major Advanced Design Features (1/4)

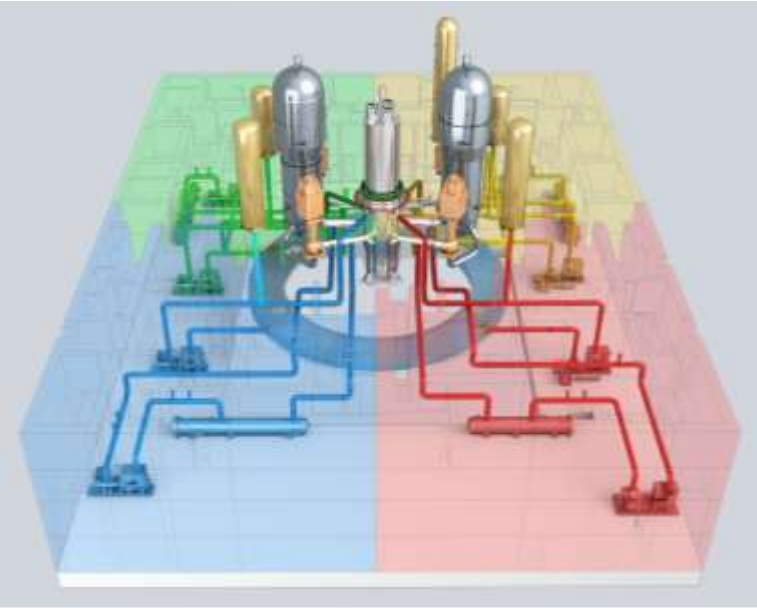
- Secondary containment and reinforced or physically separated arrangement of safety buildings against intentional airplane crash
- Stack to monitor discharged gas in the integrated manner and to enhance dispersion of discharged gas

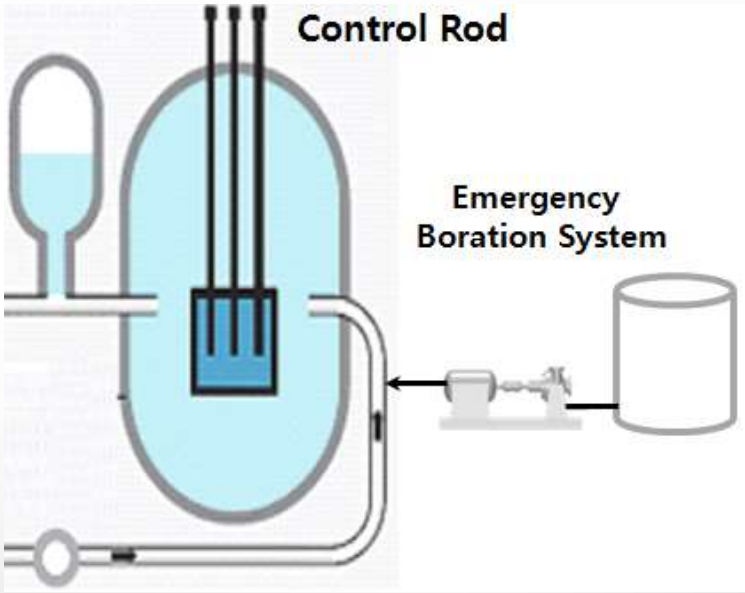




3. Major Advanced Design Features (2/4)

- **Redundancy**
  - N+2 Design : SC-2 systems to mitigate DBC 3 & 4 accidents
  - N+1 Design : SC-3 systems to mitigate DBC2, DEC and Severe Accidents
- **Diversity**
  - System or component level alternative measures against CCFs of systems performing safety functions in the event of DBC2 & DBC 3

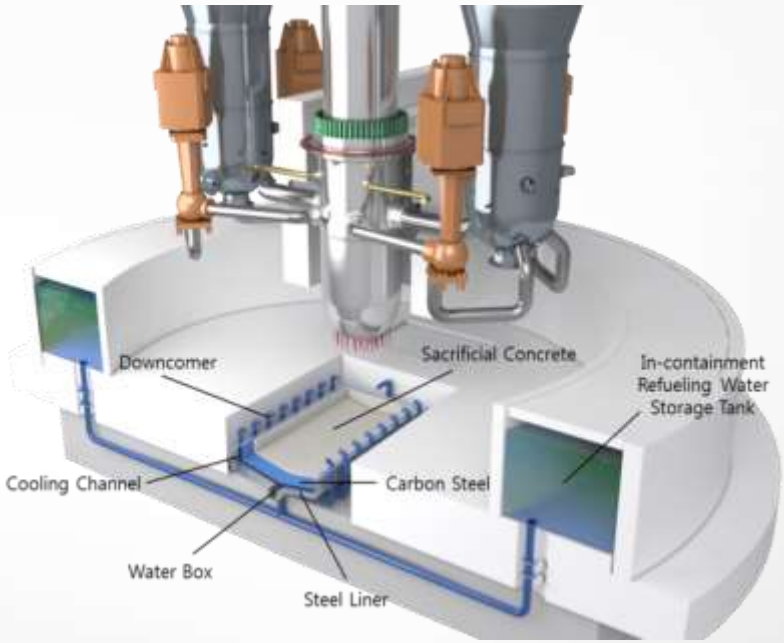




3. Major Advanced Design Features (3/4)

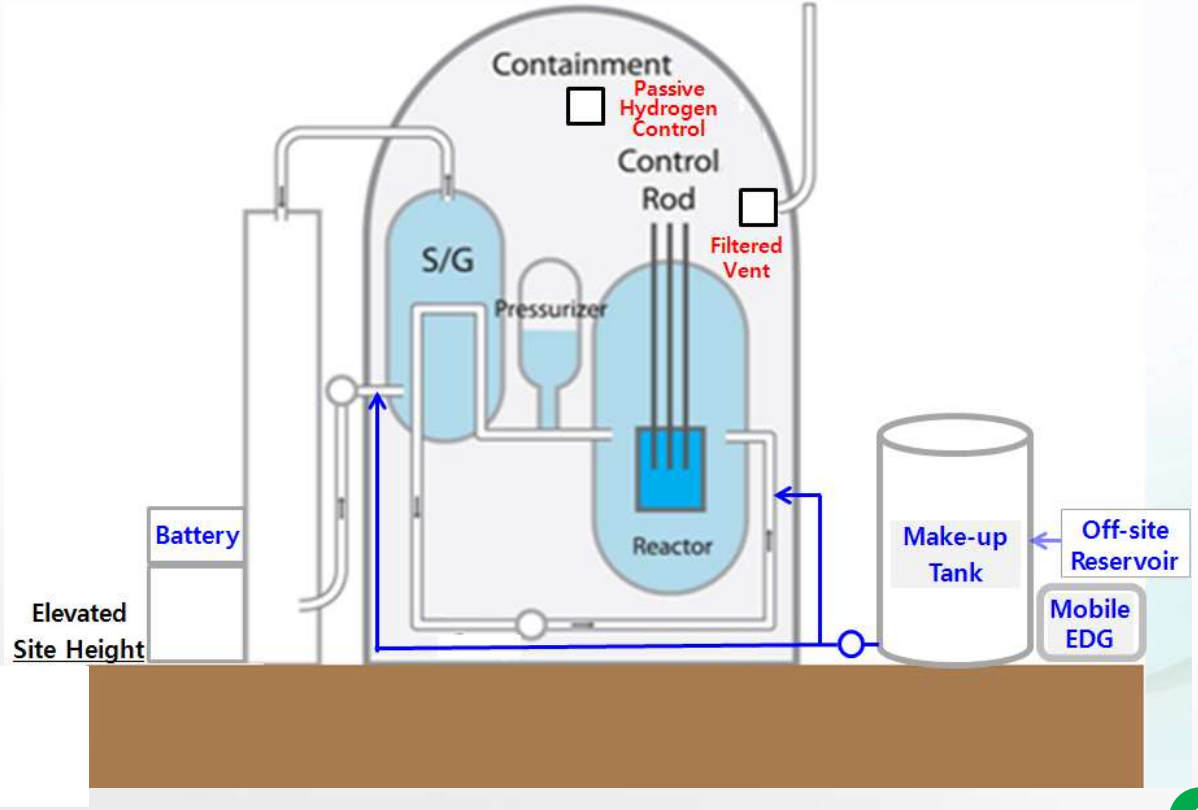
- **SAs dedicated mitigation systems to preserve the containment integrity independent of safety systems for Design Basis Conditions**

System	Function
Passive Corium Cooling System	Preventing interaction between molten core and pressure-bearing materials of the containment
Emergency Reactor Depressurization System	Preventing high pressure molten ejection
Containment Spray System	Preventing containment over-pressurization
Passive Hydrogen Control System	Maintaining hydrogen concentration in containment below 10 v/o
Instrument System	Monitoring status of plant condition
Electrical System	Supplying power to SAs dedicated systems by using battery and AACs



3. Major Advanced Design Features (4/4)

- **Reinforced waterproof function against external flooding**
- **Protection designs against loss of electrical power & ultimate heat sink**
  - External injection paths for emergency cooling of RCS, SG and SFP
  - Mobile generator, capacity-reinforced and flood-protected batteries



4 Closing Remarks

4. Closing Remarks

- EU-APR is customized for the European markets
  - Adopting new safety features with enhanced DiD concept
  - Considering recent licensing issues (aircraft crash, Fukushima accident)
  - Complying with European requirements and environment
- Major Characteristics in nuclear design
  - Structure
    - ✓ Double containment design
    - ✓ General Arrangement based on physical separation
  - System
    - ✓ Fully 4 Trains design for important safety systems
    - ✓ Diversity design for reactor shutdown and decay heat removal
    - ✓ Dedicated Severe Accident mitigation systems

THANK YOU