Contents

1. Introduction
2. Major Safety Design Characteristics
3. Summary
1. Introduction

- Technology Overview
- APR1400 Development
- Evolutionary Technology Development
- Design Goals
Evolutionary Advanced Light Water Reactor Technology

- Offering significant advances in safety and economics
- Design addresses the expectation of utilities for ALWR
- Design complies with up-to-date regulatory requirements of Korea and US and IAEA requirements
- Severe accident mitigation design features
- Eight units, four in Korea and another four in the UAE, currently under construction
Strategy

- Design adopting evolutionary improvement strategy based on proven standard/reference design
- Incorporate advanced design features to enhance safety and operational flexibility
- Optimize design for economic improvement
- Compliance with the Utility Design Requirements (domestic & world-wide)
  - Proven Technology
  - Constructability
  - Regulatory Stabilization
  - Maintainability

Clean Nuclear, Safety First!

NSSS Division
**Evolutionary Technology Development**

**APR 1400**
- 1,400 MWe
- Under Construction
- SKN # 3, 4, SUN # 1, 2, BNPP 1, 2, 3, 4
- System 80+
  (CE, 1300MWe)

**OPR1000**
- 1,000 MWe
- In Operation
  - YGN #5, 6 ('02/'02)
  - UCN #5, 6 ('04/'05)
  - SKN #1, 2, SWN #1
- Under Commissioning Test
  - SWN #2

**Improved OPR1000**
- 1,000 MWe
- In Operation
  - YGN #5, 6 ('02/'02)
  - UCN #5, 6 ('04/'05)
- Under Commissioning Test
  - SWN #2

**NSSS Design**
- Palo Verde #2 (CE, 1300MWe)

**Core Design**
- ANO #2 (CE, 1000MWe)

**EPRI URD**

**ADF/PDF Latest Codes & Standards**

*OPR1000 : Optimized Power Reactor 1000*

*APR1400 : Advanced Power Reactor 1400*
Design Goals

- **Safety**
  - Core Damage Frequency < 10E-5/RY
  - Containment Failure Frequency < 10E-6/RY
  - Seismic Design Basis : 0.3 g
  - Occupational radiation exposure < 1 man·Sv/RY

- **Performance**
  - Thermal Margin > 10 %
  - Plant Availability > 90 %
  - Unplanned Trip < 0.8/RY

- **Economy**
  - Plant Capacity (Gross) : 1,455 MW<sub>e</sub>
  - Plant Lifetime : 60 years
  - Refueling Cycle : ≥ 18 months
  - Construction Period : 48 months (N-th Unit)
2. Major Safety Design Characteristics

- Improved Thermal Margin
- Advanced Fuel Technology
- Enhanced Reliability of Safety Systems
- Digital I&C System
- Severe Accident Mitigation
- Protection Against External Hazards
Improved Thermal Margin

Reactor Coolant System

- Thermal Power: 4,000 MW
- Designed with increased thermal margin

- Reactor Vessel
  - 4 train DVI
  - Low RTNDT
  - ERVC

- Pressurizer
  - Large volume
  - 4 POSRVs

- Steam Generator
  - Plugging Margin: 10%
  - Tube Material: I-690

- Reactor Coolant Pump
  - Rated Flow: 7.67 m³/s

- Integrated Head Assembly
Major Improvement

- Increased thermal margin of larger than 10%
- High burnup of 55,000 MWD/MTU
- Improved neutron economy
- Improved seismic resistance
- Improved the resistance against fretting wear
- Debris-Filter Bottom Nozzle
- Improved Fuel Productivity

/http://www.knfc.co.kr/
Enhanced Reliability of Safety Systems

- **Safety Injection System**
  - 4 independent trains, Direct Vessel Injection
  - Water source: In-containment Refueling Water Tank
  - Fluidic Device for effective use of coolant

- **Auxiliary Feedwater System**
  - Diversity in component design: turbine driven and motor driven pumps
  - Turbine drive pump can provide cooling water without the supply of AC power

- **Enhanced Physical Separation**
  - Four-quadrant arrangement of safety systems
MMIS and I&C System

- Digital technology & data communication network
- Proven, Open & standard architecture
- Defense against common mode failure
  - Diversity between DCS and PLC
  - Reactor trip: PPS, DPS, Manual PPS Actuation
  - Alarm & Indications: IPS, QIAS-N, Diverse Indication
- Operability & Maintenance
  - Auto test, Self-diagnosis
- Computerized Procedure System
- V&V for Human Factors Engineering Design
Advanced design features for the prevention and mitigation of severe accidents

- Safety Depressurization & Vent System
- Hydrogen Control System
- Large reactor cavity & corium chamber
- Cavity Flooding System
- In-Vessel Retention & Ex-Reactor Vessel Cooling System
- Emergency Containment Spray Backup System
- Equipment survivability assessment
Protection against External Hazard

- **Design consideration for external hazards**
  - Natural disasters: earthquake, floods and site specific conditions
  - Man-made hazards: aircraft crash, fire, etc.

- **Post-Fukushima safety enhancement**
  - Installation of an Automatic Seismic Trip System
  - Reinforcement of waterproof functions
  - Reinforcing design basis of the emergency diesel generator and AAC
  - Countermeasures to address loss of cooling in the spent fuel pool
  - Installation of an external injection flow path for emergency cooling
  - Securing mobile generator and batteries
3. Summary

- APR1400: Safe, Reliable Technology
- ALWR Technology Development in Korea
APR1400, Evolutionary ALWR
- Advanced design features for safety enhancement
- Design features for severe accident mitigation
- Enhanced economics via uprated power, longer design life, longer fuel cycle, performance improvement and enhanced constructability
- 4 units currently under construction in Korea and another four units in the UAE

Proven technology minimizes technical and licensing uncertainties
- Proven by operation of reference technology
- Proven by licensing approval
- Proven by R&D programs

Technology development is continuously underway for further safety improvement.
### ALWR Technology Development with Safety Improvement

<table>
<thead>
<tr>
<th>Reactor Model</th>
<th>OPR1000</th>
<th>APR1400</th>
<th>APR+</th>
<th>PPP</th>
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<tr>
<td>First Commercial</td>
<td>1995</td>
<td>2015</td>
<td>~ 2025</td>
<td>~</td>
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<tr>
<td>Operation</td>
<td></td>
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<tr>
<td>Size</td>
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<td>$&lt; 1 \times 10^{-6}$/RY</td>
<td>“Zero” Severe Accident</td>
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Thank you!