Long-term Planning of Nuclear HRD in Korea

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Nuclear Training & Education Center

IAEA Technical Meeting from 1 to 4 Oct. 2013
Contents

- Process of Nuclear HRD Road-mapping
- Nuclear Policy and Program in Korea
- Nuclear HRD Demand and Supply in Korea
- Nuclear HRD Plan in Korea
- Conclusion
Process of Nuclear HRD
Road-mapping
Process of Nuclear HRD Road-mapping

Nuclear Energy Policy Setting-up

NPP Program Setting-up

NPP Human Resource Demand-Supply Analysis

NPP Human Resource Development (HRD)

Establishing Nuclear Institutes & Industries

Establishing Nuclear E&T Institutes
Nuclear Policy and Program in Korea
The AEPC establishes a CNEPP every 5 years for the promotion of nuclear R&D and industry.
The CNEPP has been formulated every 5 years since 1997, in compliance with the Atomic Energy Act.
The fourth CNEPP was established in November 2011.
Nuclear Energy Policy and Plan in Korea

The 4th CNEPP

Vision

Role model as the world best nuclear country [nuclear use/promotion 2.0 : To the leading era of nuclear safety]

Policy Goals

Obtaining growth engines for take-off

- Securing public acceptance
- Creating growth engines of high value
- Reinforcing sustainable infrastructure

6 Strategies

- Ensuring safety for public acceptance
- Promoting export by innovation
- Expanding nuclear use for stable energy supply
- Reinforcing international role as advanced country
- Creating new radiation market by strategic support
- Reinforcing virtuous cycle of nuclear infrastructure

(Ref) MSIP (2013)
Nuclear Energy Policy and Plan in Korea

The 4th CNEPP

[Strategy 1]
Ensuring nuclear safety for public acceptance

1-1. Design of the best nuclear safety management system
1-2. Design of environmental-friendly RW management system
1-3. Promotion of nuclear safety culture and communication with the public

[Strategy 3]
Promotion of export by innovation

3-1. Enhancing competitiveness of commercial NPP
3-2. Development of new (small-medium and research) reactor for export
3-3. Enforcement of infrastructure for export support

(Ref ) MSIP (2013)
http://www.kaeri.re.kr
Nuclear Energy Policy and Plan in Korea

The 4th CNEPP

[Strategy 5]
Expansion of nuclear use for stable energy supply

5-1. Expansion of share of nuclear power generation
5-2. Stable fuel supply and nuclear use diversification

[Strategy 6]
Reinforcement of virtuous cycle of nuclear infrastructure

6-1. Design of nuclear R&D system for excellent product
6-2. Fostering global nuclear workforce

(Ref) MSIP (2013)
Nuclear Power Plants in Korea

As of Mar., 2013

<table>
<thead>
<tr>
<th>Site</th>
<th>In Operation</th>
<th>Under Construction</th>
<th>Total (2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gori</td>
<td>6 (5,137)</td>
<td>2 (2,800)</td>
<td>8 (7,937)</td>
</tr>
<tr>
<td>Wolseong</td>
<td>5 (3,779)</td>
<td>1 (1,000)</td>
<td>6 (4,779)</td>
</tr>
<tr>
<td>Yonggwang</td>
<td>6 (5,900)</td>
<td>-</td>
<td>6 (5,900)</td>
</tr>
<tr>
<td>Uljin</td>
<td>6 (5,900)</td>
<td>2 (2,800)</td>
<td>8 (8,700)</td>
</tr>
<tr>
<td>Total</td>
<td>23 (20,716)</td>
<td>5 (6,600)</td>
<td>28 (27,316)</td>
</tr>
</tbody>
</table>

Source: www.khnp.co.kr

- Gori (#1,2,3,4,5,6)
- Wolseong (#1,2,3,4)
- Shin-Uljin (#1,2)
- Uljin (#1,2,3,4)
- Yonggwang (#1,2,3,4)
- Shin-Gori (#1,2,3,4)
- Radioactive Waste Disposal Facility (Under construction)

**Radioactive Waste Disposal Facility (Under construction)**

**Under Construction**
- OPR1000: Shin-Gori (#2)
- APR1400: Shin-Gori (#3,4), Shin-Uljin (#1,2)
National Structure related to Nuclear Energy in Korea

- **President**
  - Prime Minister
  - AEPC
    - Approval of national policy and development plan
  - Office of R&D Policy, Space and Nuclear Technology Bureau
    - Nuclear R&D
    - Nuclear human resources development
    - Nuclear international cooperation
    - Radiation research, development and application
  - Office of Energy and Resources, Nuclear Industry Bureau
    - Promotion of nuclear industry
    - Radioactive Waste Management
    - KRMC
    - KEPCO
    - KEPCO E&C
    - KEPCEF
    - KEPCO NF
    - KHNP
    - Doosan Heavy I&C
    - KAERI
    - KONICOF
    - KIRAMS
    - Universities

- **NSSC**
  - Nuclear Regulatory Bureau
  - Radiation Protection and Emergency Preparedness Bureau
  - KINS
  - KINAC

(Ref ) MSIP (2013)
Nuclear Education and Training Organizations in Korea

**Industry**

- KHNP (Korea Hydro & Nuclear Power Co.)
  - Nuclear Power Education Institute
    - NPP Construction & O&M Personnel
  - Nuclear Site Training Center (4 facilities)
    - Operator / Local Engineer
- KPS (Korea Plant Service & Engineering Co.)
  - Nuclear Maintenance Engineer
- KAERI (Korea Atomic Energy Research Institute)
  - Nuclear Training & Education Center
    - Nuclear Policy and R&D Manpower
    - International Nuclear Training Program
- KINS (Korea Institute of Nuclear Safety)
  - International Nuclear Safety School
    - Nuclear Safety & Regulatory Manpower
    - International Nuclear Safety Master’s Program

**Academia**

- Universities
  - Seoul National University
  - Korea advanced institute of Science & Tech. (KAIST)
  - Hanyang University
  - Kyung-Hee University, etc.
- KEPCO-INGS
  - International Nuclear Graduate School
    - Nuclear Business & Technology Expert
    - Masters/Doctoral Courses

(Ref) Korea Nuclear Association (KNA), (2013), Development of Nuclear HRD Model, May.

http://www.kaeri.re.kr
Collaboration Network between Nuclear Organizations

Nuclear R&D Institutes
- Development, Acquisition, Dissemination of Nuclear Technology
- Training Nuclear Expert

Universities
- Education in Nuclear Eng.
- Education in Science & Eng.
- BS, MS, PhD Degree

Government
- Nuclear Policy and Promotion
- Planning of Nuclear Power
- Nuclear Regulation and Control

Regulatory Authority
- Licensing, Inspection
- Evaluation and Analysis of Nuclear Safety
- Training for Nuclear Safety

Industries
- Construction, Design & A/E
- Manufacturing of Component and Equipment
- Manufacturing of Nuclear Fuel

Utilities
- Operation and Maintenance of NPP
- In-house Training for NPP Personnel

Society & Associations
- Coordination & support
- Cross-sectoral Training

(Ref) Korea Hydro & Nuclear Co., LTD (KHNP) (2013), Nuclear Workforce Training in Korea, May.

http://www.kaeri.re.kr
Nuclear HRD Demand and Supply in Korea
Consideration: Workforce Demand for NPP Recommended by IAEA

(Ref) Korea Hydro & Nuclear Co., LTD (KHNP) (2013), Nuclear Workforce Training in Korea, May.

http://www.kaeri.re.kr
## Consideration: Workforce Size and Career required for NPP by IAEA

<table>
<thead>
<tr>
<th>Scope</th>
<th>No. of Job</th>
<th>No. of Expert</th>
<th>Career Required</th>
</tr>
</thead>
<tbody>
<tr>
<td>① Pre-project activities</td>
<td>6</td>
<td>~ 46</td>
<td>1.5~5y</td>
</tr>
<tr>
<td>② Project management</td>
<td>8</td>
<td>~ 32</td>
<td>4y</td>
</tr>
<tr>
<td>③ Project engineering</td>
<td>14</td>
<td>~ 370</td>
<td>0~9y</td>
</tr>
<tr>
<td>④ QA / QC</td>
<td>14</td>
<td>~ 100</td>
<td>0~7.5y</td>
</tr>
<tr>
<td>⑤ Purchasing</td>
<td>10</td>
<td>~ 32.5</td>
<td>0~4y</td>
</tr>
<tr>
<td>⑥ Plant construction activities</td>
<td>8</td>
<td>~ 2825</td>
<td>0~6.5y</td>
</tr>
<tr>
<td>⑦ Commissioning</td>
<td>12</td>
<td>~ 194</td>
<td>0~6.5y</td>
</tr>
<tr>
<td>⑧ Operation and maintenance</td>
<td>27</td>
<td>~ 215</td>
<td>0~9y</td>
</tr>
<tr>
<td>⑨ Licensing and regulation (regulatory body)</td>
<td>10</td>
<td>~ 55</td>
<td>6.5~15y</td>
</tr>
</tbody>
</table>

9  109  ~ 3,850  0~15y

(Ref) KHNP (2013)
<table>
<thead>
<tr>
<th>Academic Discipline</th>
<th>Share (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>① Electrical and I&amp;C Engineering</td>
<td>19</td>
</tr>
<tr>
<td>② Mechanical Engineering and Mechanical Design</td>
<td>19</td>
</tr>
<tr>
<td>③ Social Science</td>
<td>8</td>
</tr>
<tr>
<td>④ Nuclear Engineering</td>
<td>7</td>
</tr>
<tr>
<td>⑤ Architectural and Civil Engineering</td>
<td>6</td>
</tr>
<tr>
<td>⑥ Chemistry and Chemical Engineering</td>
<td>4</td>
</tr>
<tr>
<td>⑦ Material Engineering</td>
<td>4</td>
</tr>
<tr>
<td>⑧ Environmental, Resource and Energy Engineering</td>
<td>3</td>
</tr>
<tr>
<td>High school Graduate</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

Consideration: Workforce by Academic Discipline

(Ref) Korea Nuclear Association(KNA), (2013), Development of Nuclear HRD Model, May.
## Consideration: Workforce required at Peak Time by IAEA

<table>
<thead>
<tr>
<th>Activity</th>
<th>Manpower classification</th>
<th>High-grade Professionals</th>
<th>Professionals</th>
<th>Technicians</th>
<th>Craftsmen</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Pre-Project activities</td>
<td></td>
<td>1</td>
<td>27</td>
<td>2</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>2. Project Management</td>
<td>Utility</td>
<td>8</td>
<td>47</td>
<td>10</td>
<td></td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>Main-contractor</td>
<td>8</td>
<td>22</td>
<td>5</td>
<td></td>
<td>35</td>
</tr>
<tr>
<td>3. Project engineering</td>
<td></td>
<td>25</td>
<td>185</td>
<td>160</td>
<td></td>
<td>370</td>
</tr>
<tr>
<td>4. Procurement</td>
<td></td>
<td>8</td>
<td>12</td>
<td>10</td>
<td></td>
<td>30</td>
</tr>
<tr>
<td>5. Quality assurance / Quality control</td>
<td></td>
<td>8</td>
<td>32</td>
<td>60</td>
<td></td>
<td>100</td>
</tr>
<tr>
<td>6. Manufacturing of equipment &amp; components</td>
<td></td>
<td>90</td>
<td>210</td>
<td>600</td>
<td>2100</td>
<td>3000</td>
</tr>
<tr>
<td>7. Plant construction</td>
<td></td>
<td>10</td>
<td>80</td>
<td>340</td>
<td>2270</td>
<td>2700</td>
</tr>
<tr>
<td>8. Plant commissioning</td>
<td></td>
<td>10</td>
<td>40</td>
<td>50</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>10. Nuclear fuel cycle (fuel fabrication)</td>
<td></td>
<td>5</td>
<td>35</td>
<td>70</td>
<td>30</td>
<td>140</td>
</tr>
<tr>
<td>11. Nuclear Licensing &amp; Regulation</td>
<td></td>
<td>45</td>
<td>5</td>
<td></td>
<td></td>
<td>50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>243</strong></td>
<td><strong>720</strong></td>
<td><strong>1447</strong></td>
<td><strong>4530</strong></td>
<td><strong>6940</strong></td>
</tr>
</tbody>
</table>

(Ref) KHNP (2013)
## Domestic Consideration: Workforce Estimation at Peak Time In Korea

### APR1400 x 2 Units

<table>
<thead>
<tr>
<th>Roles</th>
<th>Number of Engineers (Persons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Management</td>
<td>30</td>
</tr>
<tr>
<td>Construction Management</td>
<td>205</td>
</tr>
<tr>
<td>Commissioning Management</td>
<td>338</td>
</tr>
<tr>
<td>Operation &amp; Maintenance</td>
<td>330</td>
</tr>
<tr>
<td>Design &amp; Engineering</td>
<td>440</td>
</tr>
<tr>
<td>Manufacturing</td>
<td></td>
</tr>
<tr>
<td>- NSSS, T/G</td>
<td>700 β (200 Companies)</td>
</tr>
<tr>
<td>- BOP</td>
<td></td>
</tr>
<tr>
<td>Construction</td>
<td></td>
</tr>
<tr>
<td>- Management</td>
<td>400</td>
</tr>
<tr>
<td>- Workforce</td>
<td>4,200</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>6,643 +α</strong></td>
</tr>
</tbody>
</table>

*(Ref) KHNP (2013)*
## Current Status of Nuclear Work Force (Experts) in Major Organizations in Korea

<table>
<thead>
<tr>
<th>Organization</th>
<th>Roles</th>
<th>Average Work Experience (years)</th>
<th>Number of Engineers (persons)</th>
</tr>
</thead>
<tbody>
<tr>
<td>KHNP</td>
<td>Project Management, Commissioning &amp; Operation</td>
<td>≥ 15</td>
<td>5,700</td>
</tr>
<tr>
<td>KEPCO E&amp;C</td>
<td>Design &amp; Engineering</td>
<td>≥ 15</td>
<td>1,800</td>
</tr>
<tr>
<td>KEPCO NF</td>
<td>Nuclear Fuel</td>
<td>≥ 10</td>
<td>800</td>
</tr>
<tr>
<td>KPS</td>
<td>Maintenance</td>
<td>≥ 15</td>
<td>1,900</td>
</tr>
<tr>
<td>Doosan</td>
<td>Manufacturing - NSSS, T/G</td>
<td>≥ 15</td>
<td>1,300</td>
</tr>
<tr>
<td>KAERI</td>
<td>Research &amp; Development</td>
<td>≥ 20</td>
<td>900</td>
</tr>
<tr>
<td>KINS</td>
<td>Safety Review and Regulation</td>
<td>≥ 20</td>
<td>400</td>
</tr>
<tr>
<td>Construction Company</td>
<td>Construction Work (Hyundai, Daewoo, Samsung)</td>
<td>≥ 6</td>
<td>900</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>13,700</strong></td>
</tr>
</tbody>
</table>

(Ref) KHNP (2013)
Current Status of Nuclear Work Force in Total by Field in Korea

[Total 26,200 personnel, 2011 including internal administration]

- Safety includes Radiation Safety Management
- R&D includes every research activities including developing reactor, advance safety measures, etc.
- Service and support include nuclear administration, International Cooperation, HRD, and PR activities.

(Ref) Korea Nuclear Association(KNA), (2013), Development of Nuclear HRD Model, May.
Future Demand of Nuclear Work Force in Korea

[For Domestic Demand]

No. of Personnel Required for Construction and Operation of NPPs in Korea in 2011 (Approximately 24,100)

Unit: Person

- 2012: 24,753
- 2013: 25,261
- 2014: 26,274
- 2015: 27,357
- 2016: 28,227
- 2017: 29,140
- 2018: 29,777
- 2019: 30,550
- 2020: 31,200

About 3,250 to be needed

About 7,100 to be needed

(Ref) KHNP (2013)
Future Demand of Nuclear Work Force in Korea

[For UAE Demand]

Unit: Person

- 2012: 397
- 2013: 768
- 2014: 1,265
- 2015: 1,682
- 2016: 1,920
- 2017: 2,008
- 2018: 1,649
- 2019: 1,413
- 2020: 1,131

Additional 2,000 for construction and operation of the UAE NPPs

(Ref) KHNP (2013)
# Future Demand of Nuclear Work Force in Korea

## [For Domestic & UAE Demand]

### Estimated Average Annual Increase of 3.6% in HR Demand

<table>
<thead>
<tr>
<th>Sector</th>
<th>2008</th>
<th>2015</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Generation Companies</td>
<td>6,621</td>
<td>9,061</td>
<td>10,482</td>
</tr>
<tr>
<td>Architect Engineering</td>
<td>1,608</td>
<td>1,904</td>
<td>2,036</td>
</tr>
<tr>
<td>Construction</td>
<td>2,768</td>
<td>3,575</td>
<td>3,638</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>3,812</td>
<td>5,949</td>
<td>7,415</td>
</tr>
<tr>
<td>Trade</td>
<td>15</td>
<td>19</td>
<td>22</td>
</tr>
<tr>
<td>Service</td>
<td>4,265</td>
<td>5,204</td>
<td>5,586</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>1,732</td>
<td>1,935</td>
<td>2,071</td>
</tr>
<tr>
<td>Public Sector</td>
<td>639</td>
<td>1,144</td>
<td>1,517</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>21,460</strong></td>
<td><strong>28,790</strong></td>
<td><strong>32,766</strong></td>
</tr>
</tbody>
</table>

(Ref) KHNP (2013)
Demand and Supply of Nuclear Work Force in Korea

Nuclear HRD Plan in Korea
Educational Pipeline

High School Graduate

UNIVERSITY

JUNIOR TECHNICAL COLLEGE

DOCTOR (phD)

MASTER

CLASS II ENGINEER

CLASS I ENGINEER

PROFESSIONAL ENGINEER

Practice Career

Vocational Pipeline

MASTER CRAFTSMAN

CLASS I ASSISTANT

CLASS II ASSISTANT

ASSISTANT CRAFTSMAN

NO REQUIREMENT FOR PREVIOUS EDUCATION

(Ref) KNA (2013)
① Conducting recruit-related nuclear internship program
- Recruiting interns among science and engineering graduates and graduates-to-be and educate them on-site for six months

② Cultivating nuclear-purpose university
- Selecting nuclear-purpose college including graduate school up to 10 in total
- The MOU among company-university-government shall provide extra points or undergo a special employment process
③ Establishing nuclear-purpose high school
   - Establishing nuclear curriculum of energy-purpose high school and boost the employee tie with industries
   - Supporting High school near nuclear power plant to be nuclear-purpose high school

④ Reorganizing Poly-technical college
   - Establishing nuclear-specialized vocational education and training course (1~2 years) and start it from 2012.

⑤ Utilizing of retired employees
   - After establishing retired employee pool, it will be utilized in the field of design and technology development.
⑥ Support to scout for high-caliber manpower and reinforce their competence

- Applying world-class university project to nuclear–related universities
- Increasing support for NPP-related laboratories in university

⑦ Cultivating support manpower for nuclear export

- Expanding "International nuclear business manpower cultivation program" for international financing and contract
⑧ **Supporting manpower training of foreign countries**

- Supporting high-quality human resources through KINGS
- Establishing training centers abroad in collaboration with partner countries and dispatching domestic experts there
- Expanding support for southeast Asian countries
- Bringing-up customized experts for export markets
- Supporting overseas employment for young and retired experts

⑨ **International outsourcing for efficiency**

- Enlarging International Joint R&D with foreign university and research institution for advanced Science and Technology
10. Long-term management system
   - Balancing supply and demand of manpower in efficient and systematic way
   - Establishing and developing supply and demand of manpower statistics and a prediction model
   - Enhancing coordinating network between institutes concerned

11. Facilitating accompanied growth of small and medium enterprises
   - Expanding education & training support by utilities, vendors and research institutes
Thank you for your attention

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