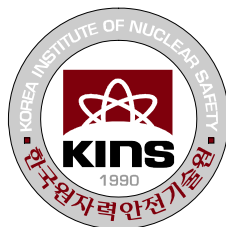


한국원자력학회 2015년 추계학술발표회 WS
(2015 Autumn KNS, GyeongJu)

월성 1호기 계속운전 규제활동 Regulatory Activities of Wolsong-1 Continued Operation



October 28, 2015

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1. Overview

- **A total of 24 NPPs, comprising 20 Pressurized light Water Reactor (PWR) NPPs and 4 Pressurized Heavy Water Reactor (PHWR) NPPs are in operation**
- **Additional 6 NPPs are under construction with 60 yr design life**
- **The operating license of a nuclear power plant in Korea is issued for its design life (30 or 40 years as specified in the safety analysis report).**
 - The design life of the PWR NPPs are 40 years except Kori unit 1.
 - The design life of the PHWR(CANDU-6) NPPs are 30 years.
 - Kori unit 1, being the first PWR plant in Korea, has reached its design life of 30 years, and the CO was permitted for this plant for 10 additional years as per the relevant rules and regulations.
 - Wolsong unit 1, being the first PHWR plant in Korea, has reached the design life of 30 years in November 2012 and the CO application for this reactor was approved in February 2015.

NPP Status of Korea *(As of October 2015)*

 In Operation

 Under Construction

 Approved for Continued Operation



24 Units
in Operation
(21,716 MW)

Wolsong Unit 1 has been in shut down since Nov. 2012 and is operational on March 2015



6 Units
Under Construction
(8,400 MW)



2 Units be
Applied for
Construction
Permit in '05.11
(2x1400MW)



Radioactive Waste
Disposal Facility
(Operational in '05.7)



Ulchin 6 units



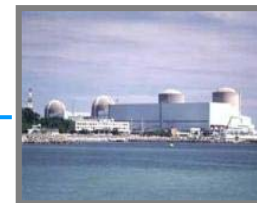
Shin-Ulchin 4units(60 yrs)



Wolsong 4 units



Shin-Wolsong 2 units



Kori 4 units



Shin-Kori 6
units(40&60 yrs)



Yonggwang
6 units



1. Overview (Cont'd)

□ Guiding Principles of CO Regulation in Korea

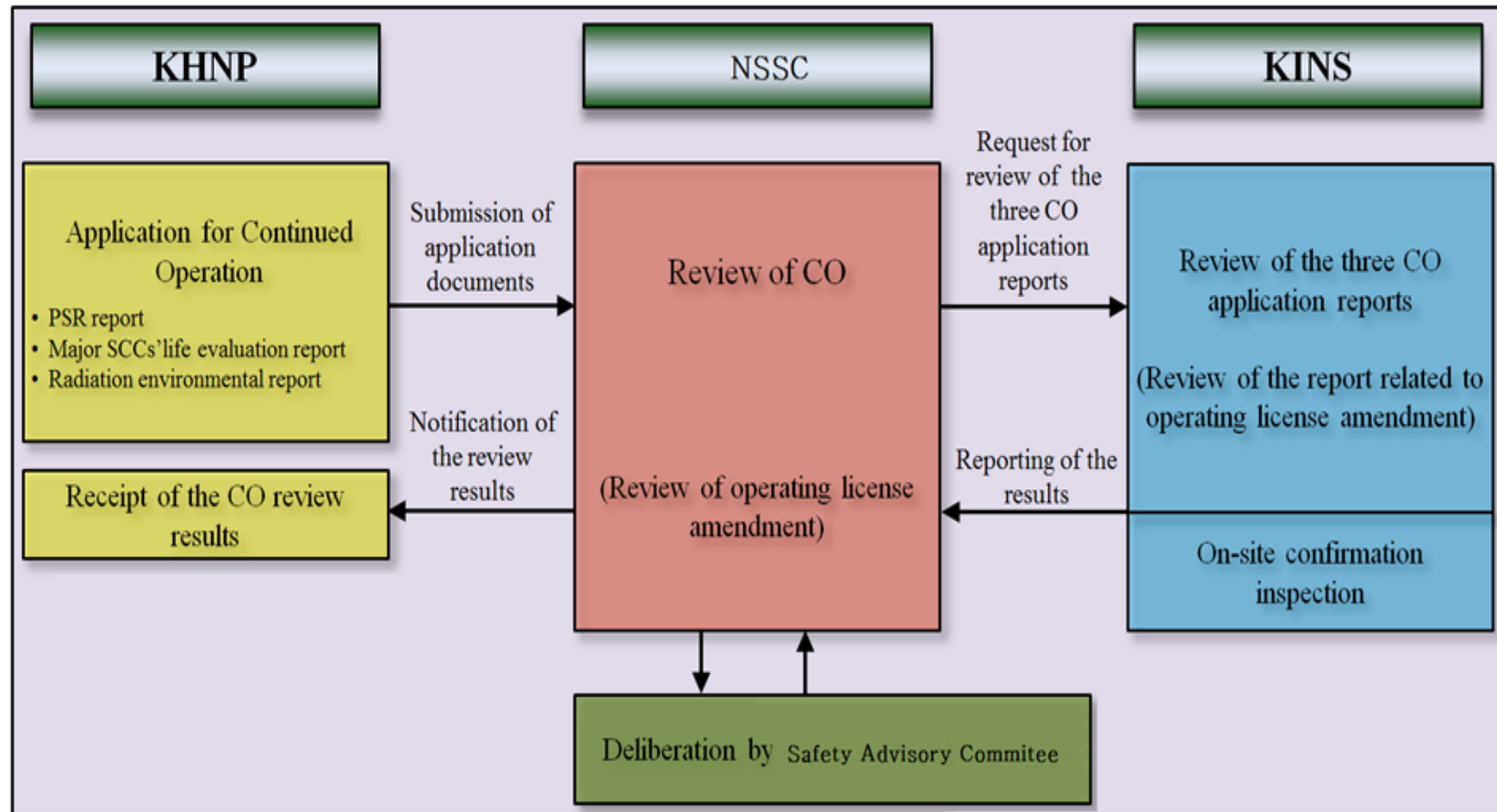
- ◆ Maintaining/Improving the Current Safety Level during CO period
 - Safety Verification with Periodic Inspections
 - Rules and Regulations of Valid Safety Reviews and Inspections
- ◆ Achieving Best Safety Level among similar NPPs' of the World
 - US-NRC Requirements of 20 yr CO period
 - IAEA PSR of 10 yr period, etc.

1. Overview (Cont'd)

■ The ASA Enforcement Decree Article 36, 37 & 38 prescribes that

- Licensee can apply for the Continued Operation (CO) of the plant beyond its design life in increments of 10 years,
- Applicant shall submit the CO application at latest two years before the expiration date of design plant life, but not more than five years before it.
- Application shall conclude the following reports
 - ✓ Periodic Safety Review (PSR) report in consideration of the period of continued operation,
 - ✓ Safety related SSCs' operational service Life-time Evaluation Report (LER), and
 - ✓ Radiological Environmental impact analysis Report (RER)

Regulatory Process and Activities of CO



1. Overview (Cont'd)

■ Review of CO documents (3 safety evaluation reports)

- KINS developed two CO review guidelines for PWR and PHWR.
 - ✓ KINS/GE-N8 for PWR , KINS/GE-N11 for PHWR
- Contents of the CO review guidelines
 - ✓ Chapter 1 (General provisions): purpose, relevant rules and regulations and acceptance criteria, application scope, and CO evaluation procedures
 - ✓ Chapter 2 (Contents): general guidelines, establishment of evaluation scope, ageing management programs, time limited ageing analysis, incorporation of operational experience and research findings, and radiological environmental impact analysis

■ Review for permission of operating license amendment

- According to the ASA Enforcement Decree Article 34, licensee shall apply for the permission of changes in the existing operating license, if any.

■ On-site inspection

- According to the MEST Notice (Reactor.035) Article 10, on-site regulatory inspection can be carried out to confirm if the corrective measures and follow-up actions are taken as described in the evaluation reports.

2. CO Rules and Regulations

- **CO rules and regulations are embedded in those for PSR.**
 - The PSR report is one of the key documents to be submitted for CO application.
- **ASA Enforcement Decree Articles 36, 37, 38 and 39**
 - Specific process of application and period of review for CO
 - CO application deadline, Application documents, Evaluation methods with technical standards

2. CO Rules and Regulations (Cont'd)

■ **ASA Enforcement Regulation Articles 20, 21**

- Detailed CO evaluation items, Applicable standards with CO evaluation criteria
- Detailed application process, detailed forms and contents of licensing basis documents
- Detailed procedure for amendment of authorization, technical standards for authorization

■ **NSSC Notice (Reactor.35) (CO)**

- Detailed particulars for the technical standards
- Detailed contents of CO application document supplementing Regulations

3. Documents for CO Application

◆ Periodic Safety Review (PSR)

- Covers the 11 safety factors as required by IAEA guidelines
 - To be IAEA 14 safety factors in '16.3, which include **PSA** and 'safety culture'
- Including
 - Follow-up corrective measures and actions taken
 - Plans made for the resolution of the safety related issues and findings identified in the process of regulatory evaluation

3. Documents for CO Application (Cont'd)

◆ Life-time Evaluation Report (LER)

- Covers ageing management for the CO period
- Including
 - Classification and selection of the SSCs subjected to life evaluation
 - Analysis of impact on the SSCs' life
 - Life evaluation of the SSCs in consideration of the surrounding environment during the CO period

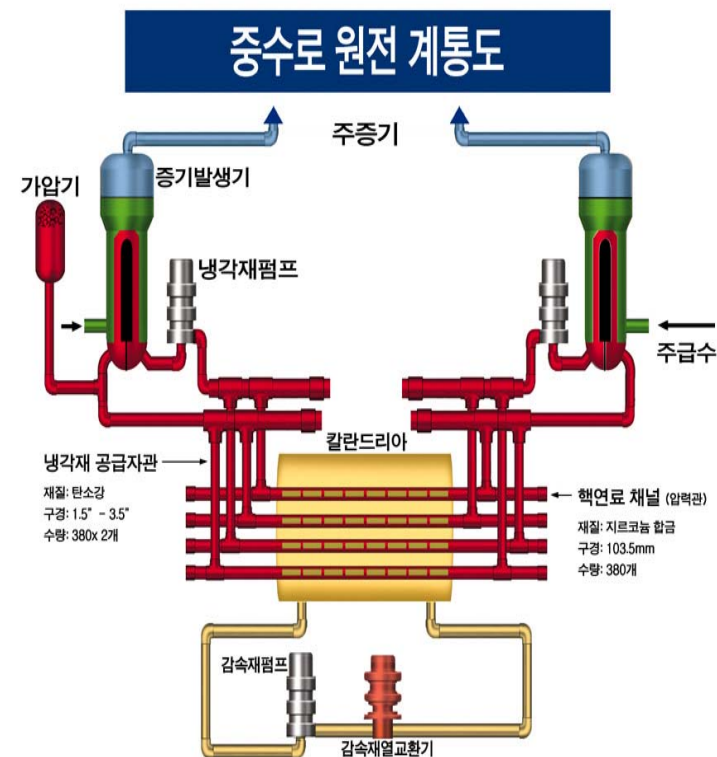
3. Documents for CO Application (Cont'd)

- ◆ Radiological Environment impact analysis Report (RER)
 - Updated version addressing all the changes since the first operation license was issued
 - Variation in the site characteristics
 - Variation in the environment around the site
 - Major design changes on the systems related to radioactive waste treatment
 - Impact of the continued plant operation on the surrounding environment
 - Environmental monitoring plan

Overview of Wolsong Unit 1

□ Plant Specifications

- Reactor : PHWR(CANDU-6)
- Provider : AECL
- Thermal Power: 2,061.4 MW_{th}
- Electric Power : 678 MWe



4. W-1 CO Review

□ Major Milestones of W-1

1982. 11. 21	Initial Criticality (Start of Design Life)
1983. 4. 22	Commercial Operation
2009. 12. 30	CO Application (Docket Review)
2010. 2. 24	Compltn of KINS Safety Review Plan
2010. 12. 15	Start of KINS Safety Review
2011. 7. 18	Compltn of Retubing (Installation of PARs)
2012. 11. 20	End of Design Life

4. Status of W-1 CO Review

W-1 CO Safety Review

☐ Purpose

Safe Operation of W-1 beyond its design life for 10 yrs

☐ Legal Basis

Atomic Safety Act(ASA) Enforcement Decree Articles 36, 37, 38 & 39

☐ Start of Review : 2010.12.15 ~ 2014.10.1

Docket Review : 2010.1.7 ~ 12.14

NSSC Advisory Committee Review Completion (2015.1.8)

NSSC Commission Approval (2015.2.27)

4. Status of W-1 CO Review

□ Safety Review Policy

- ◆ Comprehensive Safety Verification of CO Documents
 - Best Safety Level among similar NPPs' of the World
 - Aging and AMP
- ◆ Technical Expertise and Transparency in Safety Review
 - CO Experiences of CNSC and US-NRC
 - IAEA Peer Review to KHNP W-1 CO
 - KINS Homepage of W-1 CO (www.kins.re.kr/wolsong1) (2012.4.19 ~)

4. Status of W-1 CO Review

◆ Timeline

- End of design life(30 years) : Nov. 2012
- Licensing application submittal : Dec. 2009
- Launching safety review : Dec. 2010
 - Took about 1 year to docket-review
- 4 round questionnaires : Feb. 2011 – Aug. 2012
 - Total 880 questions [6 Additional Answer Sets (48 ansr's): '12.2-'14.8]
- 4 site inspections : Mar. 2011 – August 2014
 - 70 action items
- IAEA peer review : May – Jun. 2012(about 2 weeks)
- Technical Cooperation with CNSC : March 2009 – May 2015

Pressure tube replacement & Pressure Test : 2009.4 ~ 2011.7

4. Status of W-1 CO Review

◆ Main review points

- Fulfillment of relevant requirements of CO
- Taking post Fukushima accident actions
 - Taking actions for severe accident prevention and mitigation in advance (23 items)
 - Long-term actions(16 items) will be adopted
- Increasing safety level up to Wolsong-2, 3 & 4
 - Adopting recent operation experiences and research results to increase safety in modification and so on
 - Amendment of Tech. Spec. and FSAR

4. Status of W-1 CO Review

◆ Docket review

- Required 37 items modification(Feb. 2010) including,
 - Applying up-to date version of safety requirement(C-6, Rev.1) for accident analysis
 - Complete revamping of W1 Tech. Spec. per the relevant NSSC Notice
- Finished on Dec. 2010
 - Official launch time of safety review of W-1 CO
 - Amendment of Tech. Spec. and submittal of new safety analysis results

4. Status of W-1 CO Review

◆ Questionnaires

- 4 questionnaires of 880 QnA's
 - Mainly focused on ageing and integrity of reactor building etc.
 - Fukushima accident has been considered during questionnaires
- 6 questionnaires of 46 QnA's
 - e.g., Application of R-9 on ECCS

4. Status of W-1 CO Review

◆ Site inspection

- Performed 4 times
 - Total 70 action items
- All are resolved
 - e.g., **Fire** resistance of some PVC material electrical cables

IAEA Peer Review on W-1 CO (1)

◆ General information

- Duration : 29 May -7 June, 2012 (Follow-up '14.4.8-11)
- Participants :
 - 7 Experts from Canada, Czech, India, Japan, Switzerland, Sweden and IAEA
- Review scope
 - Programs and activities essential to operational safety based on IAEA Safety Standards
 - Organization and functions; configuration/modification management; safety analysis reports and plant programs; electrical and instrumentation & control components and civil structures; and radiological environmental impact

IAEA Peer Review on W-1 CO (2)

◆ Review results

- Good practices and performances
 - Procedure for electrolytic capacitor testing; systematic improvement process of maintenance programs for CANDU reactors; plant design basis; and structural life management system
- Recommendations and suggestions
 - Habitability of secondary control area; additional action to control and mitigate the degradation of containment concrete structure; improvement of maintenance record data etc.

4. Status of W-1 CO Review

- Post Fukushima accident actions
 - ◆ KHNP submitted W-1 FK Action Plan ('12.1.20)
 - 23 items were completed before CO including CFVS (filtered ventilation system of reactor building)
 - 16 items will be completed before 2015 including Water-tight Doors
 - Installation of external injection loop and Revision of SAMG are lastly reviewed

4. Status of W-1 CO Review

□ H/W Improvement Items after CO Application

- Redundancy and Automation of ECCS Hx Alternative Cooling Water Line
- Redundancy of LAC Power Bus
- Automatic Seismic Trip System
- Seismic Earthquake Alarm Window in MCR
- External Supply Line for Spent Fuel Pool
- Mobile Generator
- Improvement of Fuel Injection Facility for EPS
- CFVS
- External Injection Loop for Emergency Cooling Water

4. Status of W-1 CO Review

□ Related Licensing Items

- ◆ KHNP submitted new Deterministic Safety Analysis
OL Amendment reflecting C-6, Rev.01 ('09.12.30)
 - 7 Round Questionnaires ('10.2 – '12.11)
 - Additional Answers ('13.4.18)
 - Additional Answers ('13.6.11)
 - Approved ('13.9.11)

4. W-1 CO Review

□ Related Licensing Items

- ◆ KHNP submitted Tech. Spec. Revision OL Amendment [OP&P(Operating Policies and Principles) => latest NRC-LWR Style] ('10.10.15)
 - 4 Round Questionnaires ('10.11 – '12.8)
 - 3 Additional Answer Sets ('13.2 – '13.9)
 - Approved ('13.10.11)
- ◆ Safety Improvement Items of 1st Round W-1 PSR (2003)
 - KINS Verification of 27 Items via Bi-Annual Review
 - All 27 Items closed in September 2013

5. Closing Remarks

- ◆ SER's of PSR, LER and RER were completed on October 1, 2014
- ◆ Per CO Rules and Regulation, Safe Operation of W-1 for 10 years was approved on February 27, 2015
- ◆ CO was approved by NSSC with technical support of KINS
 - NSSC Advisory Committee Reviewed/Agreed on January 8, 2015 after 11 meetings from Jan. 2012 to Jan. 2015
 - at least 3 Open House Meetings to Wolsong Residents
<= November 1, 2013, October 16, 2014 & December 9, 2014
 - NSSC Commission Approval after at least 3 decision-making meetings of total more than 40 hours

5. Closing Remarks (전문위/안전위 “현안”)

- ◆ NSSC Commission Advisory Committee
 - 출력계수
 - 부등침하
 - PSA
- ◆ NSSC Commission (W1 CO)
 - 최신기술기준 (R-7 등)
 - 핵연료 방출 Gate
 - MSIV
 - Containment Isolation Valves of W1 & W234
 - RER 입력자료, PSA, ECCS 열교환기
- ◆ NSSC Commission : 지진(W1 Stress Test)

5. Closing Remarks (외부전문가/언론 “현안”)

- ◆ 최신기술기준 (R-7 등)
- ◆ 핵연료 방출 수문(Gate)
- ◆ MSIV
- ◆ Containment Isolation Valves of W1 & W234
- ◆ ECCS 열교환기
- ◆ 지진

5. Closing Remarks (외부전문가/언론 “현안”)

R-7과 체르노빌 사고와는 어떤 관계가 있나요?

○ 체르노빌 사고는 1986년에 발생하였고 R-7은 1991년에 발간되었기 때문에 동 사고와 R-7이 연관되어 있는 것처럼 보일 수 있지만, 체르노빌사고 이후 R-7에 추가된 내용이 없는 등 실제로는 연관이 없음.

○ 참고로 체르노빌 원전은 고압사고시 방벽기능이 불가능한 건물로(Confinement) 설계되어 있는 반면, 중수로형 원전인 월성 1호기는 격납건물 내 고압 사고시에도 충분히 견딜 수 있도록 (Containment) 설계되어 있음.

○ 또한 월성 1호기에는 격납건물 여과배기설비가 설치되어 있어 유사시 격납건물 안의 압력을 감소시킬 수 있음.

Appendix I. Expansion of PSR Safety Factors

Background and Status

- ◆ Present 11 PSR Safety Factors of ASA Enforcement Decree Article 37 are based on 1994 IAEA 50-SG-O12
- ◆ New 14 PSR Safety Factors are based on 2013 IAEA SSG-25
- ◆ 24th Meeting (2014. 4. 11) of NSSC approved ASA Enforcement Decree Article 37 revision of 14 Safety Factors
- ◆ ASA Enforcement Decree Article 37 was revised on 2014.11.19 after approval by the Cabinet Meeting

Expansion of PSR Safety Factors (Continued)

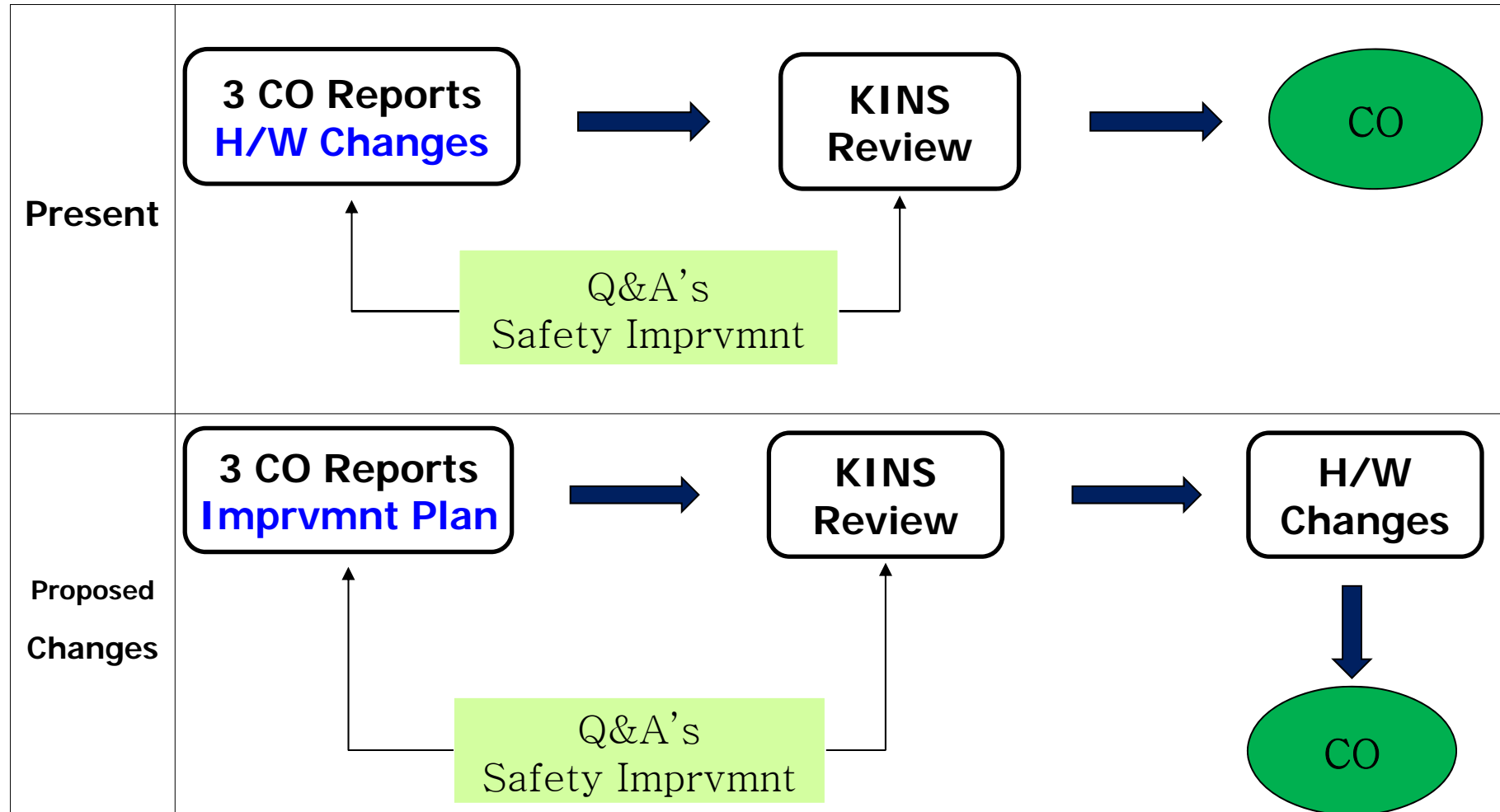
Category	IAEA 50-SG-O12(1994)	IAEA SSG-25(2013)
Plant	① Actual physical condition of the Nuclear power plant	① Plant design
		② Actual condition of structures, systems and components (SSCs) important to safety
	③ Equipment qualification	③ Equipment qualification
	④ Management of Ageing	④ Ageing
Safety analysis	② safety analysis	⑤ Deterministic safety analysis
		⑥ Probabilistic safety assessment
		⑦ Hazard analysis
Performance and feedback of experience	⑤ Safety performance	⑧ Safety performance
	⑥ Use of experience from other plants and research findings	⑨ Use of experience from other plants and research findings
Management	⑧ Organization and administration	⑩ Organization, the management system and safety culture
	⑦ Procedures	⑪ Procedures
	⑨ Human factors	⑫ Human factors
	⑩ Emergency planning	⑬ Emergency planning
Environment	⑪ Environmental impact	⑭ Radiological impact on the environment

Appendix II. Proposed Changes to ASA Enforcement Decree (2014 Spring KNS, JeJu Island)

Issues

- ◆ More Time is needed for Regulatory Review on CO Application
 - Present CO application of 5~2 yrs before the expiration date of the design life is too short for regulatory safety review AND safety improvements (e.g., H/W changes, major S/W items)
 - Major H/W changes such PT retubing before the CO application can be social issues

Proposed Changes to ASA Enforcement Decree (Continued)



Proposed Changes to ASA Enforcement Decree (Continued)

Category	Present	Proposed Changes	Comments	Prsnt ASA Enforcmnt
CO Application before Plant Life	5 – 2 yrs	10(?) yrs	More time needed for regulatory review & safety improvements	Article 36
CO Application and Review	3 CO Reports	3 CO Reports +Safety Improvement Plan	Safety Improvement Plan is regulatory reviewed to mitigate social issue of H/W changes before CO Approval	Article 36
	CO Approval after Reviews of 3 Reports and Safety Improvements	<ul style="list-style-type: none"> CO Approval after Reviews of 3 Rpts & the Plan Plant Optn after Implements of the Plan 		None
ASA based “Public Hearing” on CO	None	Newly Introduced	Minimization of social conflicts with Public Hearing before CO Approval	Article 145 (cf., ASA Article 103)

Proposed Changes to ASA Enforcement Decree (Continued)

Expected Benefits

- ◆ H/W and S/W Changes after Sufficient Regulatory Review
- ◆ Safety Improvement Plan is regulatory-reviewed to mitigate social issue of H/W changes before CO Approval
- ◆ Plan Operation is possible after proper implementation of the Safety Improvement Plan
- ◆ Minimization of social conflicts by introducing Atomic Safety Act (ASA) based “public hearing”



Thank You for your Attention