Regulatory Activity Analysis for RIDM Framework Development

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Since Severe Accident Policy (2001) was declared in Korea, individual plants' PSA report have been reviewed by KINS as a supplementary document in various licensing processes. And some risk-informed applications using these PSA results have been applied and some of them are accepted. However, there is still no case that regulatory body use PSA in regulatory decision making process directly in Korea.

We are in early stage of the main research that aims to develop of Risk Informed Decision Making (RIDM) framework in Korea. RIDM framework will be consisted by regulatory activities in which RIDM procedures are applied. The objectives of this research are to identify the regulatory activities that can be enhanced by use of risk insights and to decide promoting priorities. Almost all regulatory activities can be enhanced by PSA are identified, and more than 40 candidates are selected. And several action items are derived among these candidates by expert panels.

I. Introduction

Since Severe Accident Policy (2001) was declared in Korea, individual plants' PSA report have been reviewed by KINS as a supplementary document in various licensing processes. (E.g. Construction Permit, Operation License and Periodic Safety Review). And some risk-informed applications (e.g. RI-AOT, RI-SIT, RI-ISI) using these PSA results have been applied and some of them are accepted. However, there is still no case that regulatory body use PSA in regulatory decision making process directly in Korea. Recently, after Fukushima Daiichi accidents, numerous new regulatory issues are emerged. The request for participation of public in nuclear safety issues become stronger and feedbacks from stakeholders are increasing. In this challenging environment, it can be helpful to use PSA as quantitative safety assessment method in regulation. And also it comply with the Safety Policy Declaration (1994) which suggests the implementation of probabilistic methods to regulation.

Regulatory PSA models and RIDM procedures should be prepared for utilizing PSA in regulatory activities. In Korea, regulatory activities are conducted by the Korea Institute of Nuclear Safety (KINS). The KINS have developed regulatory PSA models, so-called MPAS (Multi-purpose Probabilistic Analysis of Safety) in cooperation with the Korea Atomic Energy Research Institute (KAERI) since 2007. The development of MPAS model have been completed for five reactor types (WH600, WH900, KSNP (CE), Framatom and CANDU) and the development for APR1400 type is in progress.

The objective of this research is to identify the regulatory activities that can be enhanced by use of risk insight. We are in the early stage of the main research that aims to develop of RIDM framework in Korea. The plan of RIDM framework development is consist of three steps.

Step 1. Identifying candidates which can be enhanced by PSA in regulatory activities of KINS,
Step 2. Assess candidates and select action items
Step 3. Developing detailed procedure and, if necessary, draft legislation for these action items.

We are in step 2, so almost all regulatory activities of KINS are analyzed by expert panels, and more than 40 candidate are identified. And several action items are derived among these candidates by expert panels with consideration of improvement and feasibility.

Action items suggested in this paper will consist of Korean RIDM framework. And draft legislation and PSA analysis tool (e.g. safety significance determination software) will be prepared for regulatory staffs.

II. Identification of Candidates

Since Severe Accident Policy declaration (2001), regulatory body (NSSC/KINS) has tried to implement risk-informed regulation in domestic regulatory framework, but there were no significant achievements yet. And the promotions for RIR is listed below,

- Risk-based Inspection and Maintenance rule pilot program (2002)
- Risk-informed graded Inspection pilot program (2006)
- Maintenance Rule Legislation Promotion (2007)
- Report on Implementation status of Risk-informed Regulation to Nuclear safety committee under Ministry of Education and Science.

In our opinion, the dominant factor of resistance is as follows,

A. Lack of consensus concerning tactical approach to increase regulatory efficiency and effectiveness – There is resistance to the concept of allocation of regulatory resource. It is also did not match with domestic legislation.
B. Lack of confidence in PSA – Due to the concern about the uncertainty of PSA, it is hard to utilize PSA for regulation decision making.

In this research, we will focus on PSA insight to be used for regulatory decision making within a range that does not cause a significant change to the current regulatory system. And the core strategy of implementation is conducting the items first which have feasibility as well as big advantage on regulatory activities.

With respect to the former factor of resistance, it is necessary to emphasize that the PSA can give an additional justification for current regulatory activities. And it is not applied as criteria whether the efficiency and effectiveness can be enhanced or not.

And with respect to the latter factor of resistance, we can say that PSA make the uncertainties explicit (it is actually an advantage of PSA) and so many staffs in traditional deterministic safety assessment (DSA) area have tendency to recognize uncertainty more easily in PSA than DSA. It is necessary to enhance the confidence in PSA. The confidence in the PSA is based on an understanding of the PSA itself. So, experience of PSA application can promote the confidence and reliability of using the PSA in regulatory body. It is expected that the confidence of the staffs on the PSA could be increased by the experiences of taking advantage from PSA in regulatory decision making.

The regulatory decision making process is embedded in various regulatory activities. Thus, systematic analysis of regulatory activities was carried out. Figure 1 shows the process diagram for identifying candidate. In Korea, KINS performs nuclear safety regulatory activities (e.g. regulatory review, inspection) except nuclear security activities. Thus, regulatory activities of KINS are listed up by analyzing the work instructions, recent nuclear safety regulatory practice etc.

And the expert panel identified RIDM candidates from each regulatory activity with panel discussion. Table I shows that candidate for RIDM application according to identified regulatory activities.

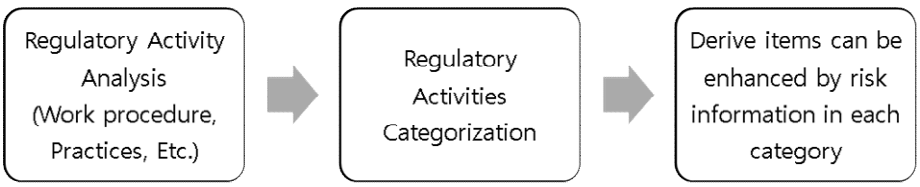

Fig. 1. Process diagram for identifying candidates

TABLE I. Identified Regulatory activities and RIDM candidates

Category		Regulatory Activities		RIDM Candidates	
1	Review (New NPPs)	1.1	License Review (Standard Design Approval, Construction Permit, Operating	1.1.1	Independent validation of submitted PSA compatibility
				1.1.2	Derivation of improvement items in regulation perspective
				1.1.3	Priority review item selection
				1.1.4	Impact assessment of design changes compared to preceding

			License)		unit
		1.2	Change Review (Construction Permit amendment, Minor change)	1.2.1	Independent risk impact assessment of construction permit amendment
2	Review (Operating NPPs)	2.1	Periodic Safety Review	2.1.1	Independent verification of submitted PSA
				2.1.2	Risk assessment of PSR safety improvement plan of licensee
				2.1.3	Intensive review items selection
		2.2	Continued Operation (CO PSR, Equipment life assessment, Radiation Environmental Impact Assessment)	2.2.1	Independent verification of submitted PSA compatibility
				2.2.2	Independent risk impact assessment of operator deducted continued operation safety improvement plan
				2.2.3	Intensive review items selection
		2.3	License Amendment Review (Operation Permit Change, Minor matters change)	2.3.1	Risk impact assessment of amendment request
		2.4	Risk Informed Application Review	2.4.1	Independent risk impact assessment to amendment request (Validating submitted risk assessment results)
		2.5	Topical Report Review	2.5.1	Independent risk impact assessment to submitted technical topical report regarding Risk Informed Application
		2.6	Radiological Emergency Plan Review	2.6.1	Sensitivity analysis of residents risk followed by emergency plan (using Level 3 PSA)
		2.7	Decommissioning Safety Review	2.7.1	Sensitivity analysis of SFP and LPSD risk according to decommission plan
3	Regulatory Inspection	3.1	Pre-operational Inspection	3.1.1	Intensive inspection items selection
				3.1.2	Significance Determination Process on Inspection Findings
		3.2	Periodic Inspection	3.2.1	Intensive inspection items selection
				3.2.2	Significance Determination Process on Inspection Findings
		3.3	Quality Assurance Inspection	3.3.1	Intensive inspection items selection
				3.3.2	Significance Determination Process on Inspection Findings
		3.4	Resident Inspector daily Inspection	3.4.1	Daily Inspection Observation Item Selection
				3.4.2	Significance Determination Process on Inspection Findings
		3.5	Suppliers Inspection (Planned / Unplanned)	3.5.1	Intensive inspection items selection
				3.5.2	Significance Determination Process on Inspection Findings
		3.6	Special Inspection	3.6.1	Intensive inspection items selection
				3.6.2	Significance Determination Process on Inspection Findings
		3.7	Radiological Emergency periodic Inspection	3.7.1	Intensive inspection items selection
				3.7.2	Significance Determination Process on Inspection Findings
		3.8	Decommissioning Inspection	3.8.1	Intensive inspection items selection
				3.8.2	Significance Determination Process on Inspection Findings
4	Others	4.1	Incident / Accident Investigation and Follow-up Review	4.1.1	Accident Sequence Analysis of the events reported by regulation (notice of government)
				4.1.2	Accident Sequence Analysis of the events which is out of regulation (notice of government)
		4.2	Radiation Accident Response	4.2.1	Accident Sequence Analysis of the events reported by regulation (notice of government)
		4.3	Operation Experience analysis	4.3.1	Importance analysis of International Operation Experience

		4.4	Regulatory Issues Response	4.4.1	Importance analysis of Regulatory Issues (Forgery Case, Performance Test missing)
		4.5	Regulatory Research	4.5.1	Prioritization of regulatory research candidates
		4.6	Regulatory Policy and Standards Establishment	4.6.1	Nuclear safety policies, regulations and standards establishment priorities and risk impact analysis
		4.7	International Cooperation	4.7.1	Prioritization of International cooperation candidates
		4.8	Miscellaneous	4.8.1	Verification of MR Importance and performance criteria
				4.8.2	Improvement of KINS's Safety Performance Indicators
				4.8.3	Review and Inspection of Nuclear Cycle Facilities and Research Reactor
				4.8.4	Review and Inspection of Radio Isotope Usage permission
				4.8.5	Review and Inspection of Radioactive Waste Treatment Facility
				4.8.6	Radiation in the Natural Environment regulation
				4.8.7	Measurement and assessment of Environmental Radiation
				4.8.8	Investigation on the person with abnormal dosimeter reading results
				4.8.9	Management of Nuclear-related license and qualification examination

III. Guidelines for Assessing Candidates

It is difficult to implement all of candidate identified in chapter II. As mentioned, it is preferred to select priority items with consideration both about safety regulation enhancement and feasibility. The former effort of USNRC about risk informed regulation is good starting point of our discussion. In SECY-01-0218, "Risk-Informed Regulation Implementation Plan" (RIRIP) (2001) (Ref.1), staffs of USNRC considered 7 guidelines and which is,

(1) Would a risk-informed regulatory approach help to resolve a question with respect to maintaining or improving the activity's safety?

(2) Could a risk-informed regulatory approach improve the efficiency or the effectiveness of the NRC regulatory process?

(3) Could a risk-informed regulatory approach reduce unnecessary regulatory burden for the applicant or licensee?

(4) Would a risk-informed approach help to effectively communicate a regulatory decision or situation?

If the answer to any of the above is yes, proceed to additional criteria; if not, the activity is considered to be screened out.

(5) Does information (data) and analytical models exist that are of sufficient quality or could they be reasonably developed to support risk-informing a regulatory activity?

If the answer to criterion 5 is yes, proceed to additional criteria; if not, the activity is considered to be screened out.

(6) Can startup and implementation of a risk-informed approach be realized at a reasonable cost to the NRC, applicant or licensee, and/or the public, and provide a net benefit? The net benefit will be considered to apply to the public, the applicant or licensee, and the NRC. The benefit to be considered can be improvement of public health and safety, improved protection of the environment, improved regulatory efficiency and effectiveness, improved communication to the public, and/or reduced regulatory burden (which translates to reduced cost to the public.)

If the answer to criterion 6 is yes, proceed to additional criteria; if not, the activity is considered to be screened out.

(7) Do other factors exist (e.g., legislative, judicial, adverse stakeholder reaction) which would preclude changing the regulatory approach in an area, and therefore, limit the utility of implementing a risk-informed approach?

If the answer to criterion 7 is no, a risk-informed approach may be implemented; if the answer is yes, the activity may be given additional consideration or be screened out.

The objectives of our research are enhancement of regulatory activities by using risk insight in current decision making process of regulatory body (NSSC/KINS). Therefore reducing unnecessary burden and improving efficiency of regulatory process in perspective of cost-benefit are out of scope. So, second and third item of RIRIP are not considered. The forth item was revised as "Could a risk-informed approach enhance the regulatory decision making process of regulatory body?" The

fifth, sixth and seventh are related to the barriers in RIR implementation, and our expert panels agreed to use these guidelines as it were generally.

Final guideline is as follows,

1. Improvement
   1-1 Would a risk-informed approach help to improving the activity's safety?
   (Very big improvement -5 / Big improvement -4 / Can be improved -3 / little -2 / disagree -1)
   1-2 Could a risk-informed approach improve the regulatory decision making process of this candidate?
   (Very big improvement -5 / Big improvement -4 / Can be improved -3 / little -2 / disagree -1)
2. Feasibility
   2-1 Does information (data) and analytical models exist that are of sufficient quality or could they be reasonably developed to support risk-informing a regulatory activity?
   (Sufficient -5 / exist -4 / not exist, but can be developed -3~1)
   2-2 Can startup and implementation of a risk-informed approach be realized at a reasonable cost to the regulatory body and licensee?
   (Very low cost -5 / Low cost -4 / moderate cost -3 / big cost -2 / very big cost -1)
   2-3 Do other factors exist (e.g., legislative, judicial, adverse stakeholder reaction) which would preclude changing the regulatory approach in an area, and therefore, limit the utility of implementing a risk-informed approach?
   (Could be implemented without any rule change, and would be no stakeholder reaction -5 / In accordance with the degree – 4~2 / would be impossible -1)

IV. Derivation of RIDM Action Items

Screening and prioritization analysis has conducted for deriving action items for which we will develop legislation and methodology. Carefully designated expert panels assess candidates with guidelines defined in chapter III. The expert panels are composed of 11 regulatory staffs (KINS), 2 from engineering company (FNC Co.) and 10 from research institute (KAERI). All expert has more than 4 years' experience in the PSA field.

The assessment table presented by Table. II is provided to each expert panels.

TABLE II. Candidate Assessment Table

Candidates list	Improvement		Feasibility		
	1-1 Safety enhancement	1-2 Strengthening regulatory DM	2-1 Availability of PSA models	2-2 Regulatory Burden	2-3 Institutional Arrangement
Candidate #1	*4*	*5*	*2*	*4*	*5*
Candidate #2	*5*	*2*	*5*	*5*	*4*
⋮	⋮	⋮	⋮	⋮	⋮

IV.A. Screening Criteria

If none of improvement category items (1-1, 1-2) acquire more than 3 point, the candidate can be screened out because it is hard to justify. And more than an item of feasibility category acquire less than 3 point, the candidate can be screened out because we can say there are big obstacles in that way. As a result of assessment, 25 items are screened out from a total of 48 items.

IV.B. Prioritization of Candidates

For prioritization of candidates, it is needed to consider both improvement and feasibility at the same time. We consider the 2-dimensional space with feasibility score Eq. (1) and improvement score Eq. (2) as x, y axis respectively. Feasibility score was simply normalized to full scale of 10 for using same scale with Improvement score.

As feasibility score, $$F = \frac{2}{3} \times \sum_{x=1}^{3} \frac{\sum_{n} Score\ of\ Expert\ panel\ n\ for\ item\ "2-x"}{\sum n} \quad (1)$$

As improvement score, $I = \sum_{y=1}^{2} \frac{\sum_{n} Score\ of\ Expert\ panel\ n\ for\ item\ "1-y"}{\sum n}$ (2)

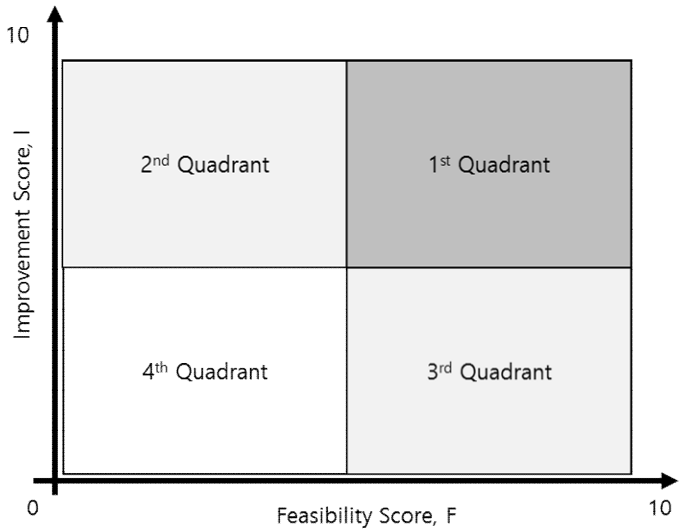

Fig. 2. Prioritization concept diagram

The implications of each quadrant of figure 2 are as follows,

- 1st Quadrant: High Priority Items
- 2nd Quadrant: Necessitated with trouble shooting Items
- 3rd Quadrant: Near term Items
- 4th Quadrant: Low Priority Items

The result of assessment is presented in figure 3. The items screened out are painted in gray.

IV.C. Derivation of Action Items

IV.C.1. High Priority Action Items (1st Quadrant)

As a result of expert panel discussion on 1st quadrant of figure 3, action items are selected as follows,

1. Accident Sequence Precursor analysis of the events reported by licensee (4.1.1)
2. Significance Determination Process on the inspection findings (and suggestions) in periodic inspection (3.2.2)
3. Derivation of improvement items in regulation perspective in CP, OL regulatory review.(1.1.2)
4. Risk impact assessment of amendment request respect to CP, OL including risk-informed amendment requests. (2.4.1, 1.2.1, 2.3.1)
5. Independent risk impact assessment on safety improvement items which is proposed by licensee in PSR and in continued operation (2.2.2) (2.1.2)
6. Independent validation of submitted PSA compatibility (Licensing, Continued operation and PSR) (1.1.1, 2.1.1, 2.2.1)
7. Impact assessment of design changes from preceding NPP in new NPP CP, OL regulatory review (1.1.4)

IV.C.1. Future work (2nd and 3rd Quadrants)

As a result of expert panel discussion on 2nd and 3rd quadrants of figure 3, future works are presented as follows,

1. Daily observation item selection of resident inspector's daily inspection procedure (3.4.1)
2. Priority review item selection in license review (SDA, CO, OL and continued operation) (2.2.3) (1.1.3)
3. Intensive inspection items selection in periodic inspection (3.2.1)
4. Significance Determination Process on the inspection findings (and suggestions) in per-operational inspection and resident inspection. (3.4.2) (3.1.2)

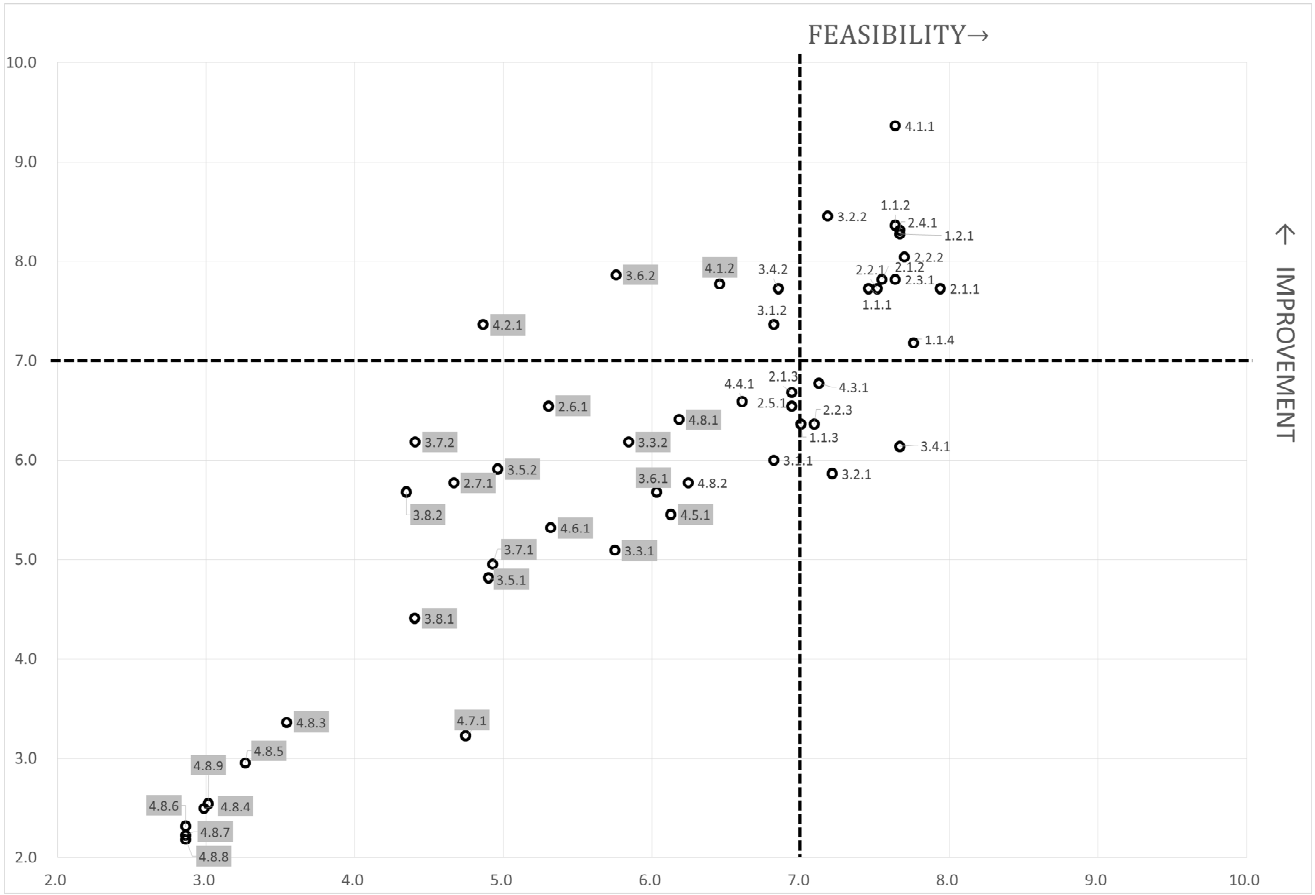

Fig. 3. Prioritization results diagram

V. CONCLUSIONS

To identify the regulatory activities that can be enhanced by use of risk insight, almost all regulatory activities of KINS are analyzed by expert panels, and 48 candidates are identified. And 7 action items are derived among these candidates by expert panels with consideration of degree of improvement and feasibility of each item. As future works, we derive 4 action items and it will be considered in step 3.

The draft legislation, detailed procedures and analysis tool for RIDM (e.g. safety significance determination software) will be prepared for regulatory staffs in step 3.

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