

The Establishment of the Study Team on Continuous Improvement of Safety

3 August 2020

Nuclear Regulation Authority, Japan

There is no end to ensure the safety of nuclear facilities, thus pursuing the continuous improvement of safety is inevitable.

The NRA has made the following efforts since its establishment.

- The NRA established the new regulatory requirements which include countermeasures against severe accidents, taking into account the lessons learnt from the TEPCO Fukushima Daiichi NPS accident. If nuclear facilities fail to conform to the new regulatory requirements, it means that they do not meet the prerequisite of operation. Conformity review has been conducted on the applications for amendments to Installation Permit based on the new regulatory requirements.
- The reform of the inspection program, which had been a long-standing challenge, was embodied in response to the recommendations from the IRRS mission in 2016. The revised oversight program was fully implemented this April. Through this program, licensees are encouraged to continuously improve safety under their own initiative on the premise that the primary responsibility to ensure safety rest with licensees, along with the obligation to confirm compliance with the latest regulatory requirements set by the NRA.
- The NRA has been making continuous efforts to enhance safety standards, even after the significant revision of the regulatory requirements based on the lessons learnt from the accident. Measures against tephra falls in response to comments in the public consultation, reassessment of the significance of volcanic eruption (Daisen-Namadake Tephra) as a result of NRA's safety research and clarification of the requirements for configuration of fire sensors in response to the finding from inspections are examples.
- The NRA has introduced the reporting system from licensees to the NRA on their voluntary activities, so-called "the Periodic Safety Assessment of Continuous Improvement". Their voluntary efforts for the improvement of safety are expected to be triggered through issuance of the reports.

These new programs have a common feature that they could bring a catalyst for change.

In other words, the design concepts include an antithesis of the conventional regulation which tends to be static, affirming the status quo and prioritizing consistency. In order for these programs to bring the actual improvement of safety, the catalyst for change needs to work, and it further needs to happen by spontaneous or intrinsic motivation of licensees or related parties.

This means that the NRA's current important challenge is to identify conditions or environment where efforts for continuous improvement of safety will be spontaneously made, to explore the ways to improve them and to deploy the mechanism to make them better.

It is natural that, with awareness of the above issue, various discussions and proposals have been made so far also in the nuclear regulation field. The question is whether these proposals have been put into actions by licensees in line with the original intent of the proposals. If the proposals and actions are not consistent, what makes the difference? Something might be hidden behind them that was not consciously put on the table in the conventional discussion framework. First of all, our challenge could possibly be to bring up these hidden issues and shed light on them from various angles.

In other words, it is also an attempt to ask how regulation in our society should be. Turning eyes on the fields other than nuclear and some cases where technical innovations happen so fast that social framework or people's awareness cannot follow, new various challenges on regulation on such technology have arisen and measures have been discussed. There might be something that the NRA can learn from such cases.

From such perspectives, the NRA would like to raise some, but not limited to, discussion points: e.g. how the environment or framework should be to bring the actual improvement of safety; how a variety of new knowledge should be treated in the environment and framework; and what the conditions are for those efforts from the new perspectives to build trust and become established.

Lessons learnt from the TEPCO Fukushima Daiichi NPS accident must not fade away. What should be done for efforts on continuous improvement of safety to keep going as time goes by and the people involved in nuclear is changing? Here, the NRA would like to open a broadly scoped and future-oriented discussion.

Members List for the Study Team on Continuous Improvement of Safety

Nuclear Regulation Authority

FUKETA Toyoshi Chairman
BAN Nobuhiko Commissioner

External Expert

ITAGAKI Katsuhiko Associate Professor
Faculty of International Social Sciences, Division of
International Social Sciences, Yokohama National University

OOYA Takehiro Professor
Faculty of Law, Department of Law, Keio University

KATSUTA Tadahiro Professor
Undergraduate School, School of Law, Meiji University

KAMEI Zentarou Senior Research Fellow, PHP Research Institute, Inc.
Specially Appointed Professor
Graduate School of Social Design Studies, Rikkyo University

SEKIMURA Naoto Vice-President, the University of Tokyo
Professor,
Department Nuclear Engineering and Management,
The University of Tokyo

YAMAMOTO Akio Professor
Department of Energy Science and Engineering, School of
Engineering / Department of Energy Engineering / Department
of Applied Energy, Graduate School of Engineering, Nagoya
University

Secretariat of Nuclear Regulation Authority

OGINO Touru Secretary-General

ICHIMURA Tomoya Director-General, Nuclear Regulation Department

KANEKO Shuichi Director-General for Oversight, International Affairs,
Fukushima Daiichi Regulation

and Other Staffs

Study Team on Continuous Improvement of Safety
Nuclear Regulation Authority Japan

Thoughts on recent back-fitting cases

Secretariat of NRA Japan

10, September 2020

Table of Contents

- 1 . Measures against OPC of three-phase current
- 2 . Measures against High energy arcing Fault (HEAF)
- 3 . Measures against the design basis seismic ground motion on the fuel cladding confinement function
- 4 . Lessons learned from Kashiwazaki-Kariwa (KK) units 6&7 conformity review
- 5 . Measures to fulfill the requirements for fire sensor
- 6 . Measures against Common Cause Failure caused by Software within Digital Safety Protection System
- 7 . Standardized Ground Motion without specific seismic source

1 . Measures against OPC of three-phase current

- Based on the operating experience of the NPP in U.S.A., regulatory actions were taken in both U.S.A. and Japan.
- U.S.NRC didn't issue back-fit in this case. As a result of the communication¹ with licensees, NRC has agreed to the licensee's voluntary initiative, and inspects it.
- On the other hand, NRA amended the regulatory requirements, and reviews the conformity for existing facilities in Japan.
- ⇒As is the case in U.S.A., is there any solution (regulatory scheme) in Japan to encourage the Licensee's voluntary initiative by utilizing administrative guidance and confirm their action status?

1: U.S.NRC gave request and notice by Bulletin and Information Notice, provided in Generic Communication Program (which is the written communication tool with licensees).

<Overview of the Case>

Measures against open phase condition (OPC)	Relevant regulatory requirements
<p>Background: On Jan. 30, 2012, Unit 2 at the Byron Nuclear Power Station (NPS) shut down safely after an "open phase" event. The shutdown was caused by unbalanced electrical voltage coming into the plant from the regional electric grid. The plant was not designed, however, to automatically turn off circuits to isolate that offsite power source and switch to emergency backup power. The plant could not detect and also the other 97 US nuclear plants could not have detected the "open phase" condition (OPC).</p> <p>NRA's action: Because the condition could happen in Japan, NRA amended the regulatory guide to stipulate that measures should be taken to detect an OPC on the transformers directly connected from the grid and to isolate the fault circuit or switch the power supply of the emergency bus automatically or manually.</p>	<ul style="list-style-type: none"> ▪Regulatory guide for NRA ordinance on standards (Power reactors, research reactors and Reprocessing facilities) ▪Regulatory guide for NRA ordinance on technical standards (Power reactors, research reactors)
	<p>Date of enforcement</p> <ul style="list-style-type: none"> ▪2014-Jul-09 for power reactors, research reactors ▪2014-Oct-29 for reprocessing facilities
	<p>Deadline of Implementation</p> <p>Before restart of operation (No grace period for reactors in operation)</p>

2. Measures against High energy arcing Fault (HEAF)

- Based on the operating experience of NPPs in Japan and the outcome of safety research conducted by NRA, regulatory requirements were upgraded in Japan.
- As the outcome of research, NRA identified the occurrence condition of common cause failure derived from a arching fire¹, and required the prevention measures² to the licensees.
- NRA amended the standards, and reviews the conformity to amended standards for existing facilities in Japan.
- ⇒Based on figures of risk evaluation, is it overlooked the knowledge related to what was not considered or modeled in evaluation?

1: a fire to occur when equipment becomes too hot due to arc discharge.

2: Before this improvement, NRA required the countermeasures on the hanging crossing gate which arching fire occurs in fact.

<Overview of the Case>

Measures against High Energy Arching Fault (HEAF)	Relevant regulatory requirements
<p>Background: USNRC has conducted a case analysis on HEAF events since the early 2000s. In addition, the OECD/NEA set up a working group on HEAF in 2009. The HEAF has been drawing attention around the world as there is a need to develop a method for evaluating the impact of HEAF from the view point of nuclear safety regulators.</p> <p>In Japan, the HEAF occurred too and was accompanied by a fire. There was a possibility that the fire could have spread more damages to the equipment. Therefore, NRA conducted safety research related to HEAF, and the knowledge on prevention of arching fire was obtained.</p> <p>NRA's action: NRA amended the requirements to stipulate that measures should be taken to mitigate the consequence of explosion by HEAF, and to prevent the occurrence of arching fire on electrical power boards by applying high-speed circuit breakers that can cut-off arc energy fast enough.</p>	<ul style="list-style-type: none"> ▪NRA ordinance on technical standard (Power reactor and Reprocessing) ▪Regulatory guide for the NRA ordinance on technical standard (Power reactor) ▪Review guide of HEAF
	<p>Date of enforcement</p> <p>2017-Aug-08</p>
	<p>Deadline of implementation</p> <ul style="list-style-type: none"> •2 years after enforcement for non-safety bus in the operating plants •4 years after enforcement for safety bus with EDGs in the operating plants •Before 1st operation for plants under construction

3. Measures against the design basis seismic ground motion on the fuel cladding confinement function

- Based on the experience of conformity review of NPPs in Japan, NRA incorporated this into regulatory requirements.
- NRA has required to evaluate confinement function of fuel cladding against earthquake. Based on the experience of conformity review of NPPs, NRA determined to refine this requirement.
- NRA amended the standards and required Licensees to apply with the re-evaluation result. Existing facilities were reviewed the conformity with the revised standards.
- ⇒Where NRA has no discretionary (if it's sufficient that Licensee makes documentation of the re-evaluation result), is it possible in Japan to simplify the review procedure?

<Overview of the Case>

Measures against the design basis seismic ground motion on the fuel cladding confinement function	Relevant regulatory requirements
<p>Background: Before the new regulatory requirements were introduced, 'maintaining their geometric configuration for removal of decay heat was required for a fuel cladding against earthquake'. It became necessary to evaluate confinement function of fuel cladding against earthquake, because the standard seismic motion (hereafter, the standard seismic motion Ss) under the new regulatory requirements has become larger than the past.</p> <p>NRA's action: NRA amended the requirements to stipulate that measures should be taken to ensure that the confinement function of the fuel cladding can be maintained even when an earthquake with the standard seismic motion Ss occurs during the normal operation or the anticipated operational occurrences.</p>	<ul style="list-style-type: none"> ▪NRA ordinance on standards (Power and research reactor) ▪NRA ordinance on technical standard (Power reactor) ▪Regulatory guide for NRA ordinance on standards (Power and research reactor) ▪Regulatory guide for NRA ordinance on technical standard (Power reactor)
	<p>Date of enforcement</p>
	<p>2017-Sep-11</p>
	<p>Deadline of implementation</p>
	<p>By 2019-Sep-30</p>

4 . Lessons learned from Kashiwazaki-Kariwa (KK) units 6&7 conformity review

- Based on the experience of conformity review of NPPs in Japan, NRA incorporated this into regulatory requirements.
- The measure showed by the licensee in the review was rational and appropriate for the intent of the standards, then NRA amended the standards to require the measure. Existing facilities were reviewed the conformity with the revised standards.

⇒If NRA introduces every good voluntary proposals into standards,

- It can cause negative incentives that good proposals add to Licensees' burden.
- There doesn't exist the category of voluntary measures which exceeds the regulatory requirement.

So how to distinguish where introduce to requirement from where consign to Licensees?

<Overview of the Case>

Measures to prevent over-pressure failure of CV (Lessons learned from Kashiwazaki-Kariwa (KK) units 6&7 conformity review)	Relevant regulatory requirements
<p>Background: NRA decided that the technical lessons learned from TEPCO KK units 6&7 conformity review should be incorporated to the requirements.</p> <p>NRA's action: NRA amended the requirements to stipulate that the licensees should provide following measures:</p> <ul style="list-style-type: none"> • to install an alternative circulation core cooling system which can reduce pressure and temperature of reactor containment vessel while keeping the confinement function of CV, in order to prevent any damage of CV caused by over pressure in sever accident • to prevent negative effects caused by water vapor which is generated from spent fuel pool • to install blowout panel which can close from the Main Control Room in order to protect operators from radiation appropriately in case of emergency. 	<ul style="list-style-type: none"> ▪NRA ordinance on standards (Power and research reactor) ▪NRA ordinance on technical standard (Power reactor) ▪Regulatory guide for the NRA ordinance on standards (Power and research reactor) ▪Regulatory guide for the NRA ordinance on technical standard (Power reactor) ▪ Review guide of SA (Power reactor) ▪Review guide of effective evaluation (Power reactor)
	<p>Date of enforcement</p>
	<p>2017-Dec-14</p>
	<p>Deadline of implementation</p>
	<p>By the end of the first Periodic Facility Inspection after 2019-Jan-01</p>

5. Measures to fulfill the requirements for fire sensor

- Based on the inspection experience of NPPs in Japan, NRA incorporated this into regulatory requirements.
- Required equipment was installed in a different manner from the NRA's intention, so NRA amended the standard to clarify the intention.
- Existing facilities were reviewed the conformity with the revised standards.
 - ⇒When NRA "retrieves" the intended level to resolve a conflict of views between the NRA and licensees, is it difficult to consign to licensees?
 - ⇒How does NRA consider the relationship between the review and inspection under the New Inspection System, in the context of Continuous Improvement?

<Overview of the Case>

Measures to fulfill the requirements for fire sensor stipulated in Fire Service Act.	Relevant regulatory requirements
<p>Experience: During the inspection of the operational safety program, it was found out that, among different-spec fire sensors installed in the fire area/zone, heat sensors did not fulfill the requirements stipulated in Fire Service Act.</p> <p>NRA's action: NRA amended the requirement to stipulate that measures should be taken for all the different-spec sensors to fulfill the requirements for fire sensor stipulated in Fire Service Act.</p>	<ul style="list-style-type: none"> ▪Regulatory guide for NRA ordinance of fire protection
	<p>Date of Enforcement</p>
	<p>2019-Feb-13</p>
	<p>Deadline of implementation</p>
	<p>5 years after enforcement, and before the end of the first Periodic Facility Inspection or before start operation</p>

6 . Measures against Common Cause Failure caused by Software within Digital Safety Protection System

- In this Case, NRA is improving the regulation taking into account the international development.
- NRA identified the appropriate level that licensees installing the digital safety protection system with software should also install Diverse Actuation System※.
- On the other hand, licensees have already installed most of identified equipment voluntarily.
- ⇒ Is there any regulatory scheme that licensees satisfy the level set by NRA as a voluntary measures?
- ⇒ Or, Is there any regulatory scheme to provide the requirement focusing on only one of diversified equipment?

※The system which isn't possibly lose the function simultaneously by common cause failure caused by software within digital safety protection system, such as the system which can actuate without software.

<Overview of the Case>

Measures against Common Cause Failure caused by Software within Digital Safety Protection System	Relevant regulatory requirements	
<p>Background: As one of Important issues for NRA in 2019 , it was raised to introduce Measures against CCF (Common Cause Failure) of DSPS (Digital Safety Protection System) into the regulation.</p> <p>NRA's action: NRA decided to study a revision of the current regulation based on improvement of reliability, also considering the international development. So NRA established the Study Team on CCF and such of DSPS in NPPs, and the Team studied the revision.</p> <p>As a result, NRA identified the appropriate level of Measures. Since Licensees stated a intention of voluntary initiative, NRA decided to hear the proposal of Licensee's voluntary initiative in the Study Team as a interim action.</p> <ul style="list-style-type: none"> ● Necessary to install new equipment ● The Study Team follows the status of Licensee's voluntary initiative. 	Under consideration	
	Date of enforcement	TBD
	Deadline of implementation	TBD
		TBD

7. Ground Motion without specific seismic source

- In this Case, NRA is improving the regulation based on the outcome of the Study Team established in NRA.
- At first, Licensees stated they played a main role to improve evaluation method in a proactive manner, but it spent too much time to consider. At last, NRA determined to play a main role instead, and developed new evaluation method.
- NRA will amend the standards, and review the conformity to amended standards for existing facilities in Japan, where the Design Basis Ground Motion is changed by the re-evaluation.

⇒ How does NRA oversee licensee's voluntary initiatives? What should NRA do when their action are unsatisfactory?

< Overview of the Case >

Ground Motion without specific seismic source	Relevant regulatory requirements
<p>Background: NRA established the Study Team in order to develop a evaluation method of "Ground Motion without specific seismic source" applicable everywhere in Japan, at commission meeting on Nov. 29 ,2017.</p> <p>As a result of discussion on the standard spectrum of "Ground Motion without specific seismic source", the Study Team wrote the report on the result at Study Team's 11th meeting on Aug. 7, 2019.</p> <p>NRA's action: NRA discussed the report and decided to introduce it into the regulation at commission meeting on Aug. 28, 2019.</p> <ul style="list-style-type: none"> ● It is necessary to re-evaluate Ground Motion, but It depends on Installations to need change of DBGM (Design Basis Ground Motion) or equipment. ● Where to need change of DBGM, a facility were reviewed the conformity with the revised standards. 	Under consideration
	Date of enforcement
	TBD
	Deadline of implementation
	TBD