The Nuclear Risk Research Center

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Nuclear Safety in Japan

- Deterministic approach
- Few PRAs were done prior to Fukushima
- After Fukushima, the Nuclear Regulation Authority issued very conservative deterministic regulations
- All 48 units are currently shutdown
- A local court blocked the restart of Takahama 3 and 4 over the approval of the NRA.
- “It is internationally recognized that our new regulatory regime is one of the strictest . . . but that was apparently not understood (by the judge),” Chairman of the Nuclear Regulation Authority (NRA)

The Nuclear Risk Research Center

Date of Establishment: Oct 1, 2014
Location: Central Research Institute of Electric Power Industry, Tokyo
Research activities are conducted mainly in Abiko and Komae
Number of members：Approximately 110

Nuclear Risk Research Center

<External Advisory Framework>

Executive Advisor to the Center (Dr. R. Meserve)

Technical Advisory Committee
(Chair : Mr. J. W. Stetkar)

Subcommittee (in each field)

<Framework of Internal Organization Structure>

Head of the Center (Dr. G. Apostolakis)

Acting Head

Deputy Head (Two persons)

Senior Technical Advisor

Planning and Administrative team（approximately 10 staff）
Management, External relations.

※ U=unit

Risk Assessment Research team
(approximately 40 researchers : Risk Analysis U, Plant Thermal Hydraulics U, Environment Analysis Assessment U)

External Natural Event Research team
(approximately 60 researchers : Active Fault, Ground Motion Assessment U, Tsunami Assessment U, Volcano Assessment U, Extreme Weather Impact Assessment U, Ground, Facility Fragility Assessment U)

<Conference Framework>
(including utilities and industry)

CEO Dialogue

※ CEO=Chief Executive Officer

CNO Conference

※ CNO=Chief Nuclear Officer

Technical Conference
- Working Group 1 (Risk Assessment field)
- Working Group 2 (External Natural Event field)

Conduct R&D, Support result utilization (site application, standardization etc)

NRRC Mission/Near Term Goals

1.Mission Statement

- To assist nuclear operators and nuclear industry to continually improve the safety of nuclear facilities by developing and employing modern methods of Probabilistic Risk Assessment(PRA), risk-informed decision making and risk communication.

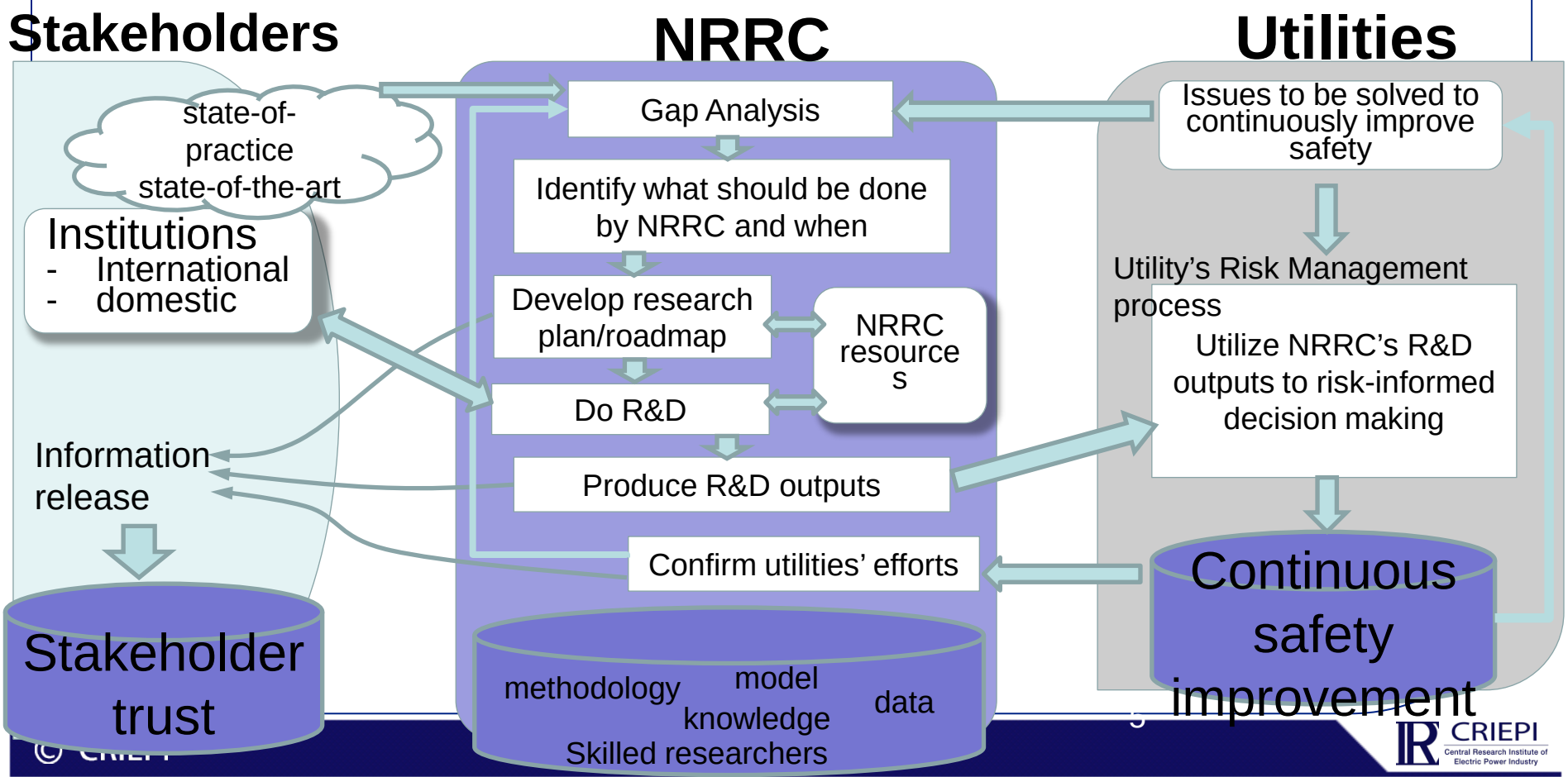
2.Near Term Goals

- Review existing PRAs (and improve, as necessary)
- Seismic PRA
- Tsunami PRA
- Infrastructure (HRA/Other Ies (fires, Internal floods, others)/ Risk communication methods)

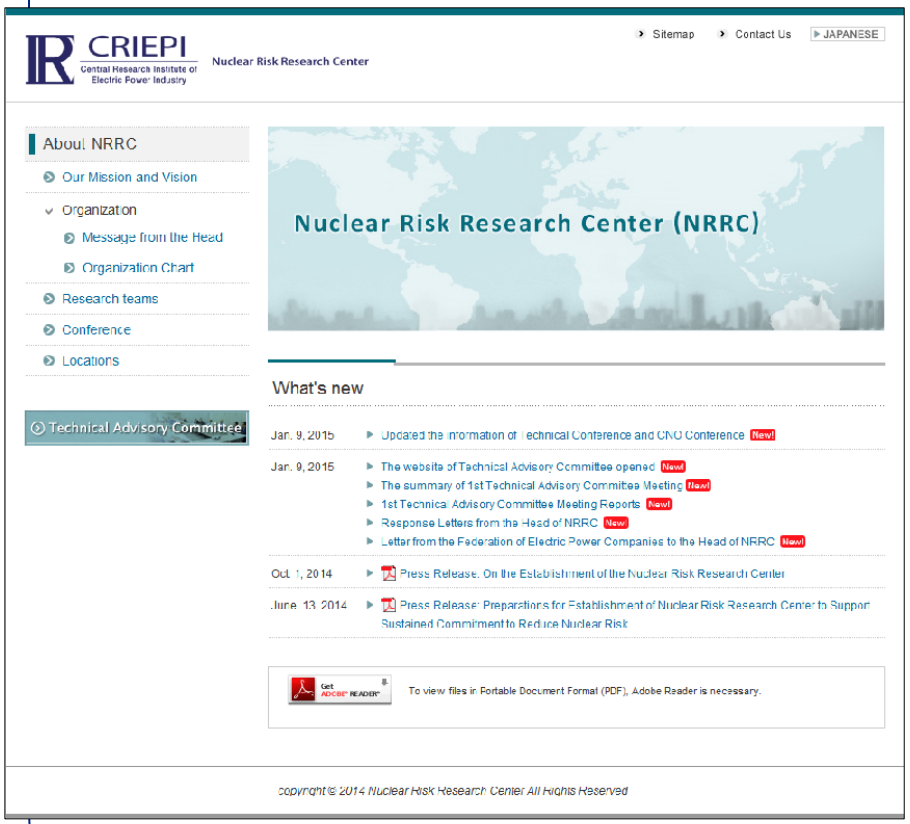
Role of the NRRC

To support utilities, NRRC will
- **Develop modern PRA methodologies and infrastructure**
- **Investigate mechanism, frequency and consequences of external natural hazards**
- **Continuously be aware of and identify new risks**

NRRC R&D outcomes



NRRC Website



http://criepi.denken.or.jp/en/nrrc/index.html

http://criepi.denken.or.jp/jp/nrrc/index.html

Committees

- **Technical Advisory Committee**
  - J. Stetkar, A. Afzali, N. Chokshi, X. Pouget-Abadie, T. Tamada, A. Yamaguchi
  - Letter reports and NRRC/industry replies are published in the website
- **PRA Promotion Team**
  - Senior utility and FEPC managers
  - Observers for Mitsubishi, Hitachi, Toshiba, et al
  - Interacts with NRRC management routinely

PRA Upgrades

- **TAC Letter**
  - The event sequence models that have been developed to support the planned restart of Ikata Unit 3 do not represent the as-built, as-operated plant
  - Differences in the designs, normal system configurations, and operating practices at Ikata Unit 2 and Unit 3
  - Failure rates should be plant-specific
  - Ikata plant personnel should be actively involved in the development and review of the PRA models
- **Industry Reply**
  - We agree with the recommendations

Human Reliability Analysis

- **Utilize the IDHEAS Framework**
  - **Identification and feasibility assessment**
  - **Human Failure Event narrative (crew response tree, crew failure modes, performance influencing factors)**
  - **Quantification (decision trees)**
- **HRA in extreme environments**
  - **Mobile equipment**
  - **Retrieval, transportation, installation**
  - **Historical record**

Seismic Risk

- **Pilot plant: A unit at a site with a second unit next to it**
- **Interactions will be explored**
- **SSHAC (Senior Seismic Hazard Assessment Committee) process for hazard assessment**
- **Fragility Assessment:**
  - **NRRC/Electric utilities have been conducting various experiments and numerical simulations in order to evaluate realistic response and capacity.**
  - **NRRC has been conducting the fragility evaluation based on the earthquake experience data.**

The SSHAC Process

- The utility is the project sponsor. NRRC supports
- Expert panels
  - Expert panels will be selected for SSC and GMC.
  - Number of experts in each panel is 3-4.
- Technical Integrator
  - Highly experienced of seismic hazard assessment and SSHAC implementation.
- Objective: To produce the *community* probability distribution of seismic risk
- Experts act as proponents and evaluators
- Four workshops will be held
  - Mechanism for avoiding weights

Seismic PRA/Shaking table test

- **CRIEPI/NRRC has been conducting shaking table tests up to 20g for various important equipment.**

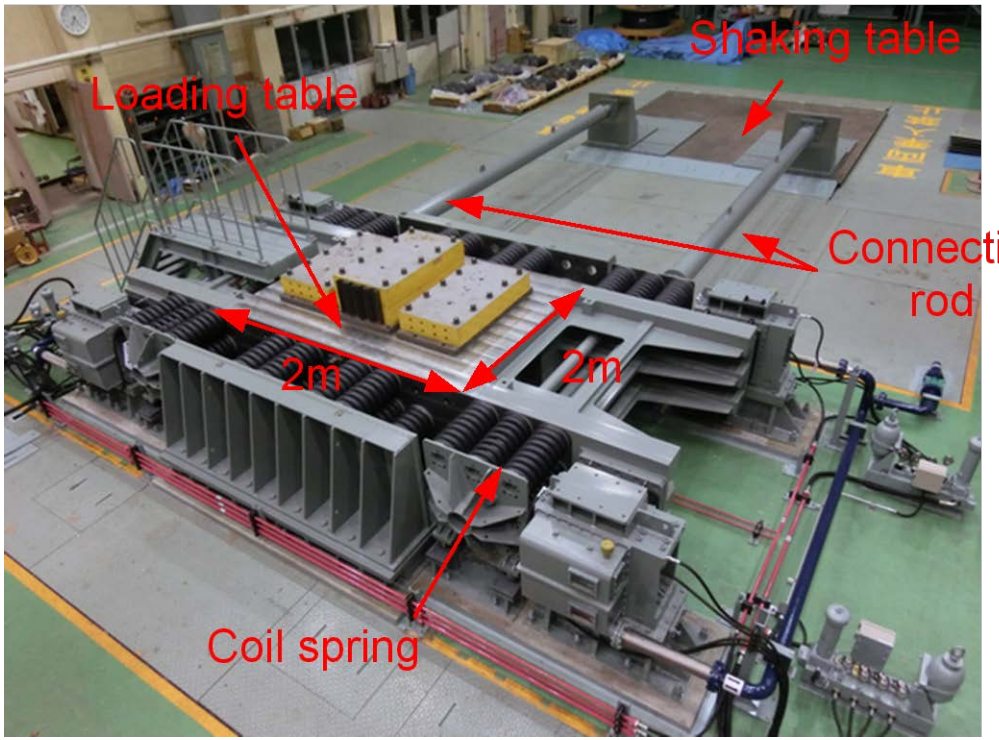
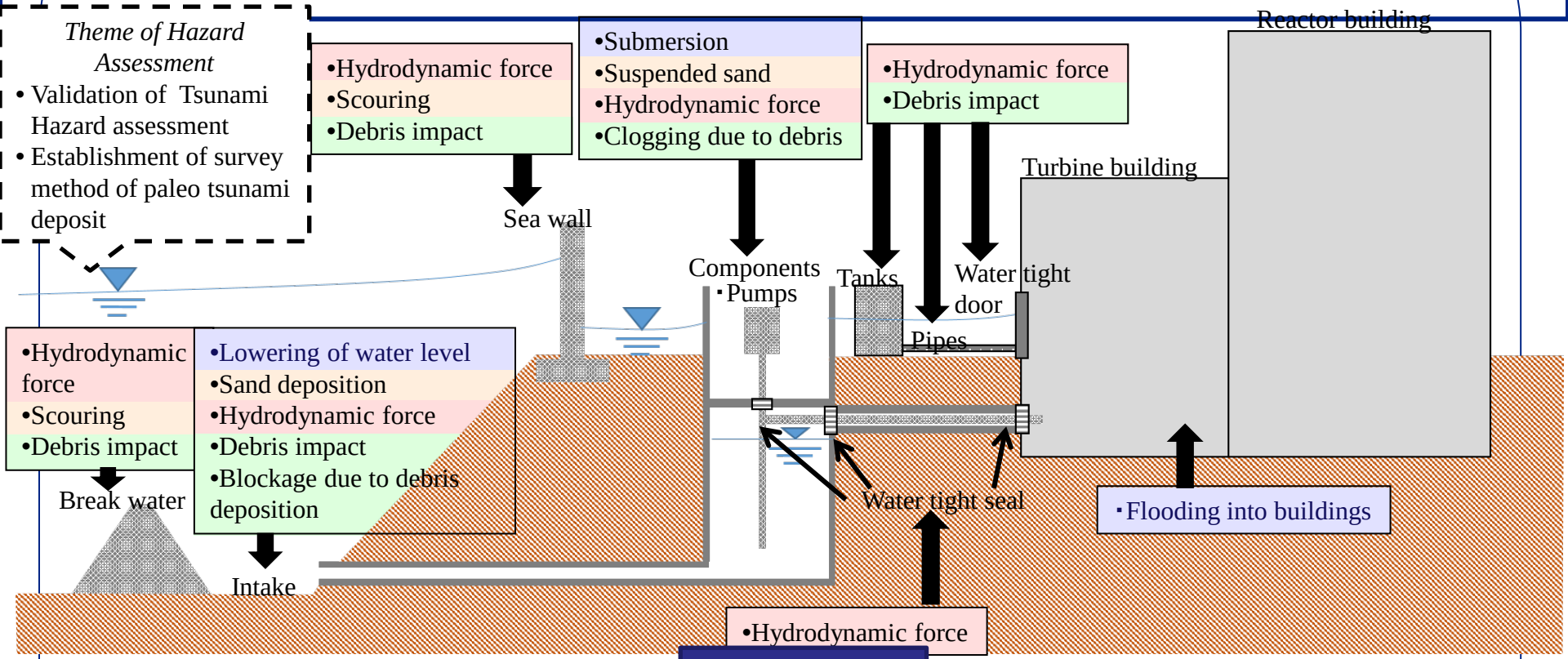


table size :2m/2m
Max Load:10t
Max Acc.: 20g
Max Vel.: 3.14m/s
Max Disp.: 0.05m
Freq.:10Hz/sine curve

Tsunami effects on NPP

Theme of Hazard Assessment
- Validation of Tsunami Hazard assessment
- Establishment of survey method of paleo tsunami deposit



Category

: Water level
: Hydrodynamic load
: Debris
: Sediment (sand)

Tsunami PRA/Key Challenges

1.Hazard Assessment:

- SSHAC implementation (similar to Seismic PRA)

2. Fragility Assessment:

- Pre-Fukushima accident; tsunami evaluation focused mainly on water level change.
- Hydrodynamic load, Debris impact, Debris deposition and so on should be considered.
- There are no practical procedures for fragility evaluation regarding these impacts.
- NRRC has started to establish the methodology for tsunami fragility evaluation.

Experiments (2014)

Relationship between the debris impact (collision) force and speed was investigated. A real car was drifted in the tsunami-inundation flow, and impacted on a wall. The impact force was measured.

- **Experimental condition**
  - **Tsunami velocity : 2.6m/s – 6.0m/s**
  - **Depth : 0.2m – 0.8m**

- **Measurements**
  - **Impact force on the wall**
  - **Impact speed of the car**
  - **Water depth**
  - **Velocity**

Other External Natural Hazards

- **Seismic Fault Displacement**
- **Tornado/Typhoon**
- **Volcanic Activity**
- **Combination of hazards**