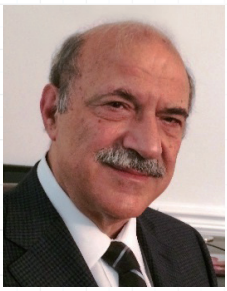
Nuclear Risk Research Center

CRIEPI
Central Research Institute of Electric Power Industry

About the NRRC

The Nuclear Risk Research Center (NRRC) was founded in October 2014 to serve as a center for research and development so that nuclear operators acquire technologies and expertise necessary for continuously improving safety in nuclear power generation.
Since its foundation, the NRRC has utilized its research resource and infrastructure to uncover the mechanism of massive earthquakes and tsunamis which may bring about tremendous damage despite its very low frequency of occurrence, to develop countermeasures by predicting accident progression, and to improve the Probabilistic Risk Assessment (PRA) method. NRRC assists nuclear operators to improve safety and reduce the risk of nuclear power generation by providing results and expertise gained through these comprehensive efforts.



The Head
Dr. G. Apostolakis

*Former commissioner of the US Nuclear Regulatory Commission

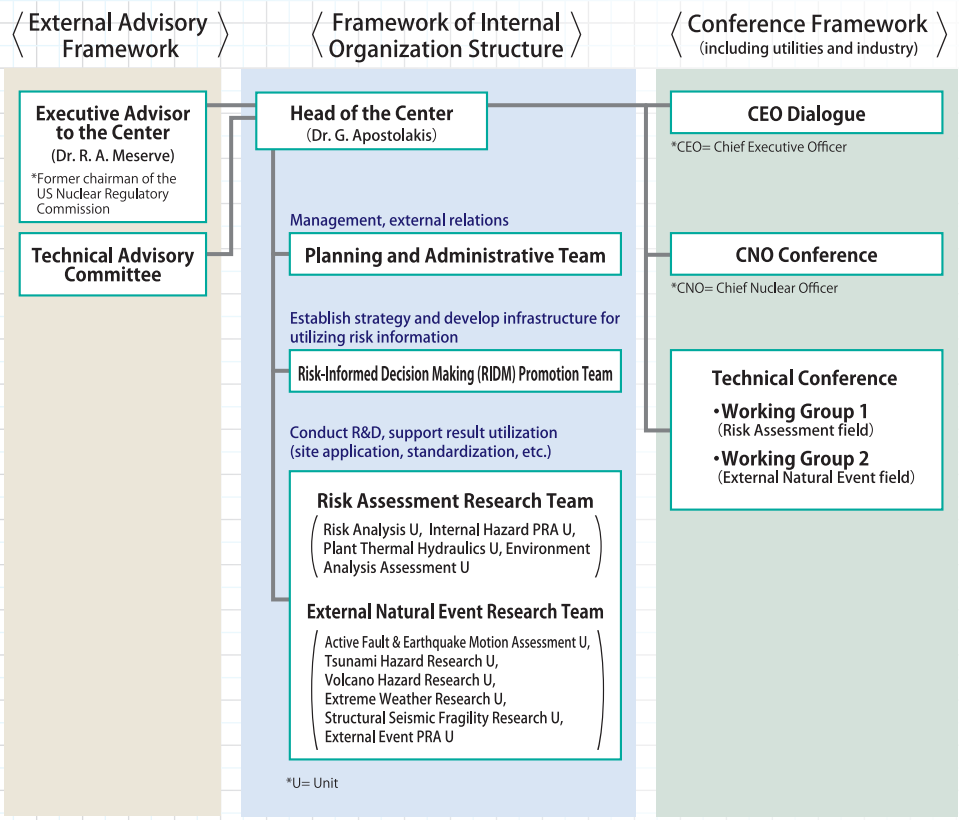
Mission Statement

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

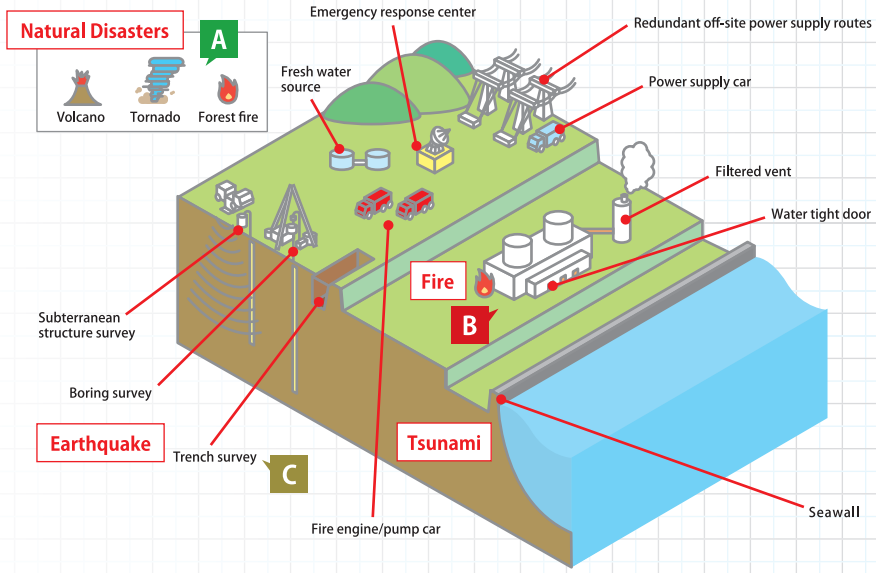
Vision Statement

To become an international center of excellence in PRA methodology and risk management method, thereby gaining the trust of all stakeholders.

Organization Chart



Contribution to utilities' efforts to comply with the New Regulatory Requirements

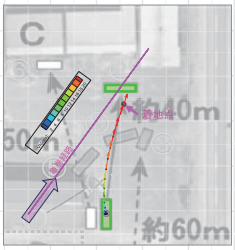


Key countermeasures required by the New Regulatory Requirements

NRRC R&D results applied at real sites

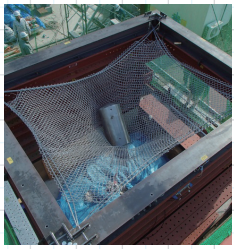
A Tornado

NRRC developed the methods to assess the maximum wind velocity of a tornado and the speed of tornado-generated missiles. Also, NRRC developed the methods to protect the facilities with important safety functions from tornado-generated missiles and assessed its effectiveness in collision tests. These methods are implemented in many power stations as tornado protection measures.



Assessment result for truck movement caused by tornado

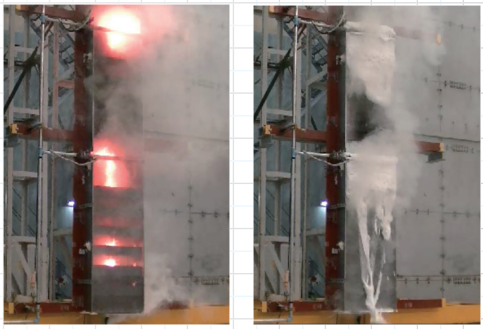
*Assessment results closely replicated actual direction and distance the truck was moved.



Penetration resistance test for protection method using high strength wire mesh to protect against tornado-generated missiles

B Fire

NRRC confirmed the effectiveness of the incipient fire detection and automatic fire suppression systems to prevent the fire spreading in the power station in verification tests simulating cable fires.



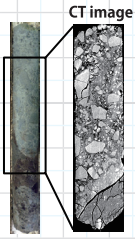
Test to verify the capabilities of the automatic fire suppression system during cable fire

C Active fault

NRRC performed geological surveys with utilities both within and outside of NPP sites to determine if faults existed around the sites. If faults did exist, NRRC assisted utilities to assess their potential activity and potential interlocking mechanism of multiple faults.

Field survey of faults by CRIEPI experts

Helical X-ray CT scanner to observe boring core samples



Observed boring core sample Internal structure of the fault fractured layer

Contribution to nuclear operators' voluntary and continuous efforts to improve safety

The NRRC supports nuclear operators by developing and providing technology and methodology necessary to improve the safety of nuclear facilities beyond the requirements of regulations.

NRRC's research results → Contribute to → **Utilities' voluntary and continuous efforts to improve safety**

Event assessment technology

Application / Feedback

- External natural events (Earthquake, tsunami, volcano, extreme weather (e.g. tornado))
- Fire, internal flooding
- Severe accident*

Risk assessment technology

- Improvement of PRA methodology
- Human reliability analysis

〈Use of risk information〉

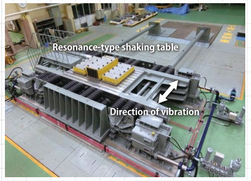
Compliance with New Regulatory Requirements → Risk assessment (PRA implementation) → Further improvement of safety

Conformity review → Restart → Stable operation

*Severe accident: Major accidents causing significant damage to reactor fuel

Seismic research

NRRC conducts experiments to assess the extent of seismic vibration to which critical equipment and structures of nuclear facilities can retain normal functions utilizing the resonance-type shaking table that allows for vibration testing with acceleration up to 20G (20 times the force of gravity).

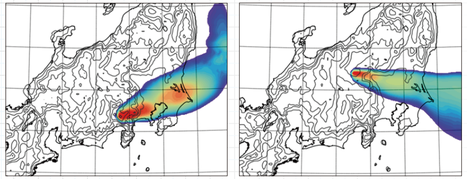


Resonance-type shaking table

Functionality test of main steam relief safety valve

Volcanic research

NRRC develops methods to simulate the accumulation of volcanic ash resulting from a volcanic eruption, and methods to perform an impact assessment of volcanic ash on nuclear facilities.

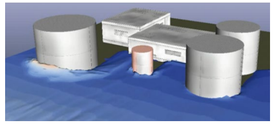

Simulation example for the accumulation of volcanic ash resulting from volcanic eruption

Tsunami research

To confirm the robustness of nuclear facilities against tsunamis, NRRC performs experiments to assess the tsunami wave force and collision force of floating debris utilizing Large-scale Tsunami Physical Simulator, capable of replicating large scale tsunami that floods inland. Also, NRRC performs the simulation of tsunami once it reaches land.


Test to assess collision power of floating debris in a tsunami


Large-scale Tsunami Physical Simulator


Simulation image of tsunami behavior in station premises

Research on risk assessment technology

NRRC develops risk assessment guides for the utilities.

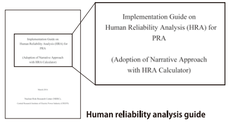
Fire PRA guide

NRRC develops a practical and effective guide for performing fire PRA in Japan. It took the U.S. guide as its starting point and updates it based on recent results of various fire tests and experience of fire PRA implementation.


Fire test of the internal arc of the high voltage electric panel

Human reliability analysis guide

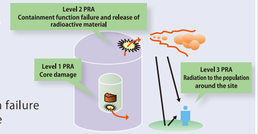
NRRC has developed a detailed qualitative method on the basis of the latest cognitive science to analyze how operators make an error. This method enables a more realistic evaluation than the conventional ones of human error probabilities at the time of accidents at nuclear power plants. NRRC has compiled this methodology into a human reliability analysis guide for the utilities.



Human reliability analysis guide

*Probabilistic risk assessment (PRA)

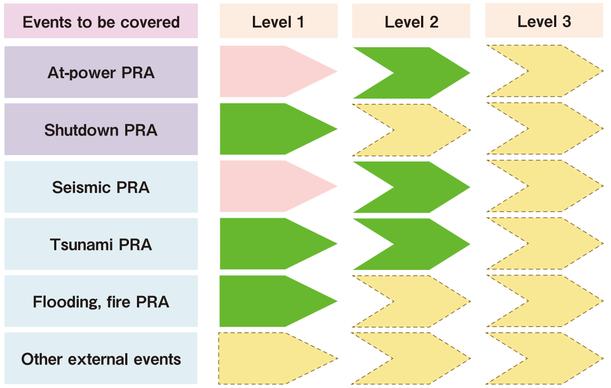
This is a method that comprehensively identifies accident scenarios that could occur at the nuclear power station and quantitatively assesses its frequency of occurrence and the level of impact.
Utilization of the PRA allows for logical and comprehensive assessment of risks in the station based on realistic conditions and can represent the significance of the contributing factors to risk numerically.
By using the results derived from PRA, safety measures can be implemented in the order of the highest cost effectiveness.
PRA consists of three categories: level one on damage to the nuclear reactor core, level two on containment vessel function failure and the release of radioactive materials; and level three on the radiation to the population around the plant.



PRA categories

Improvement of PRA methods

NRRC strives to develop PRA methods with adequate scope and features so that utilities will be able to use them in considering measures to improve safety in nuclear power generation.



Developing Level 1 PRA methodologies

NRRC develops component methodologies to improve PRA models which cover fire, flooding, tornado, and volcano

Development of Level 2 PRA method

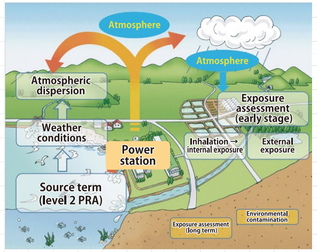
Improve assessment method of event progression during severe accident

NRRC improves the quality of event progression analysis code for severe accidents by applying new insights such as advancing temperature distribution assessment method in containment vessel with the application of numerical fluid dynamics.

Development of Level 3 PRA method

Review the level 3 PRA assessment code for its applicability in Japan

NRRC considers challenges in implementing the U.S. level 3 PRA assessment code in Japan and studies the impact of various parameters on the assessment result.



Assessment subjects in the U.S. Level 3 PRA assessment code

Improvement of the seismic PRA method

NRRC and a utility implement the probabilistic seismic hazard assessment based on the guideline developed in the U.S.* for the first time in Japan, organize an expert meeting and conduct research and development necessary for seismic hazard assessment.

*Probabilistic seismic hazard assessment procedures developed at the SSHAC (Senior Seismic Hazard Analysis Committee)


Expert discussion at a SSHAC workshop

Support for utilities to use risk information

The NRRC supports utilities to implement a risk-informed decision-making process for safety improvement in nuclear power generation.

RIDM* implementation strategic plan

NRRC conducts the survey/analysis of leading international case studies and considers how utilities should implement the RIDM process. NRRC shares the results with the utilities and proposes an RIDM implementation strategic plan.

*RIDM: Risk-Informed Decision Making
Decision-making for safety improvement measures of nuclear facilities while considering quantified risk information gained from a PRA

PRA expert review

NRRC invites international experts to review a PRA at the pilot plants* to develop a "Good PRA"*, a foundation for RIDM.

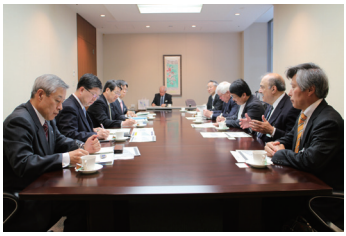
*Good PRA: A PRA method of high accountability and reliability that meets international state of the practice and reflects the as-built and as-operated status of each station to the extent possible.

*Pilot plant: Ikata NPS Unit 3 (PWR: Pressurized Light Water Reactor), Kashiwazaki-Kariwa NPS Units 6, 7 (BWR: Boiling Light Water Reactor) are the designated pilot plants.
They implement international good practices of PRA methods proactively and also implement the results of NRRC research and development.
Each utility will benefit from knowledge and information acquired at the pilot plants.


Discussion with international experts during a PRA expert review

Collaboration with the industry

NRRC works closely with nuclear operators in various levels, such as top management, chief nuclear officers and general managers of nuclear power divisions to share information on challenges nuclear operators face, discuss NRRC's activities and research plans and application of its results; all for improving safety and reducing risk of nuclear power generation in unison with the industry.



Discussion with top management of nuclear operators

Visit to nuclear power station

Benefit from expertise of international experts

NRRC reflects advice and insights from "Technical Advisory Committee" and other international experts to its R&D and other activities so that NRRC provides the outcome of the highest international standard.
NRRC acquires and shares latest information and knowledge by enhancing dialogue and cooperation with regulators, utilities and research institutions overseas.

Technical Advisory Committee (TAC)*

Meeting with a delegation of the US Nuclear Regulatory Commission

Discussion with experts from the Électricité de France (EDF) regarding seismic research

*Technical Advisory Committee (TAC): The committee is composed of internationally recognized experts in areas relevant to improving the safety of nuclear power generation. It reviews and assesses NRRC's research plans and results, and provides recommendations.

Open activities and information release

The NRRC works both openly and transparently to win trust from external stakeholders.
NRRC also widely distributes information regarding its activities and results via the website and symposiums.
NRRC experts participate in various meetings and conferences held both domestically and abroad to present research results.

Offering information via website

Hosting symposiums

Contact

2017.7

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