English

Operator Efforts Toward Enhancing Safety in Japan

April 26, 2013

THE FEDERATION OF ELECTRIC POWER COMPANIES
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Operator Efforts Toward Enhancing Safety

As operators who have the primary responsibility of ensuring safety, efforts that aim for the world's highest level of safety will be implemented.

Response to the Fukushima Daiichi Nuclear Power Station accident

Perspective of the countermeasures

Never cause the same accident to occur again

"Multiplexing" and "Diversification"

- **Ensuring power source**
  - Ensure power supply to the Main Control Room, etc., by deploying power-generating vehicles, etc.
- **Ensuring cooling**
  - Ensure water supply to the reactor and steam generator, etc., by deploying fire pumps, etc.
- **Anti-inundation measures**
  - Anti-inundation measures of switchboards, batteries, and pumps

・Evaluation of fault activity on the premises
・Evaluation of interrelation of surrounding active faults and review of the standard earthquake ground motion

Response aiming for the world's highest level of safety

Goal to aim for

Ensure the world's highest level of safety

(1) Expansion of safety enhancement measures

Severe accident prevention and impact mitigation efforts that include countermeasures comprising 30 items of technical findings, etc.

(2) Check and review of safety enhancement measures

Review of and response to indications in various accident investigation reports, including the report from the government's Nuclear Incident Investigation and Verification Committee

(3) Further promotion of safety enhancement measures

Establish JANSI as a mechanism to promote continuous safety enhancement measures

Analysis of the Fukushima Accident

[Earthquake effects]

○The reactor automatically shut down normally due to the earthquake
●External power was lost due to the collapse of transmission line towers caused by landslides, etc.
○All emergency diesel generators automatically started up normally
○Equipment required for reactor cooling operated normally

[Tsunami effects]

●Important equipment such as the emergency diesel generators and switchboards were flooded
●The sea water pump was damaged and the sea water cooling function was lost
●All AC power (external power + emergency diesel generators) were lost

A total loss of AC power and loss of the sea water cooling function continued over the long-term, causing severe core damage and damage to the containment vessel.

Safety enhancement measures

“Multiplexing” and “Diversification”

Ensuring power source

Ensuring cooling

Anti-inundation measures

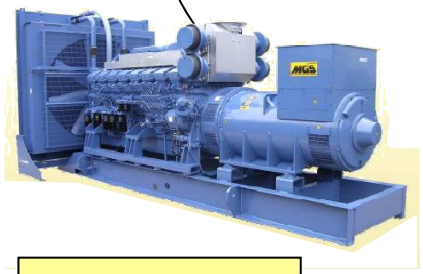
Various Countermeasures that have been taken so far (Ex. of PWR)

Anti-inundation measures
Doors sealed

(1) Monitoring

Battery

Main control room



Primary containment vessel

Release into the atmosphere

(3) Release non-radioactive steam into the atmosphere

Pressurizer

Steam

Reactor vessel

Steam generator

Water

Turbine

Generator

To drain

Cooling water (sea water)

Circulating water pump

Rotate using steam

P

Feed water pump

Auxiliary feed water turbine-driven pump

Ensuring power source

Ensure power using an air-cooled emergency generator, etc.

Anti-inundation measures

Doors sealed

(2) Supply water using a steam-driven pump

(2) Supply water using a steam-driven pump

Condensate storage tank

Fresh water tank

Ensuring water source

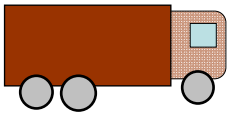
Ensure water supply using fire pumps, etc.

Various Countermeasures that have been taken so far (Ex. of BWR)

Ensuring power source

Deployment of power-generating vehicles, air-cooled power equipment, etc.

Air-cooled power equipment



Power-generating vehicles

Anti-inundation measures

Modification and sealing of building doors and pipe penetrations, etc.

Ensuring cooling

Portable power pump (engine driven)

Diversification of alternative coolant injection pumps

Diversification of water sources

Large-capacity water supply vehicle

Air-conditioning system

Main Control Room

Monitoring instruments

Battery

Primary containment vessel

Reactor core isolation cooling water (steam driven)

Safety relief valve

Stack

To turbine

Reactor pressure vessel

Tank

Condensate storage tank (Water source)

Motor-operated pump

Rivers

Sea

Sea water intake pump

Residual heat removal system

Equipment cooling water system

Vent valves

Enhancing the reliability of containment vessel vents

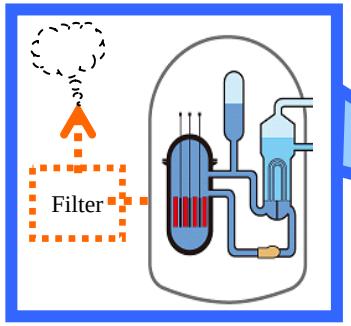
Deployment of equipment for field operation, development of procedures, and training

Alternative sea water cooling using large-capacity water supply vehicles and portable heat exchangers, etc.

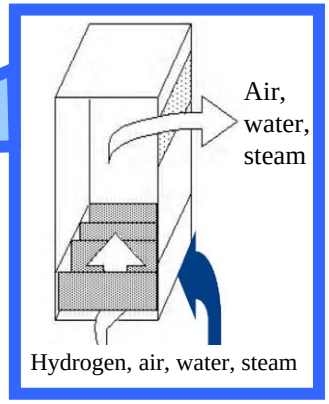
Continuous Improvement of Equipment and Operation Aspects (Ex. Of Ohi Unit 3, 4 PWR)

- As continuous improvement of equipment and operation aspects, measures such as the installation of filter vents, construction of an anti-seismic administrative building, and raising the breakwaters will be taken over the mid to long-term.

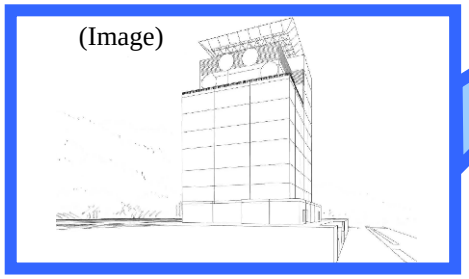
■ **Installation of filter vents**
Minimization of long-term evacuation regions (FY2015)



■ **Hydrogen explosion prevention measures**
・Installation of a static catalytic hydrogen recombiner (FY2013)



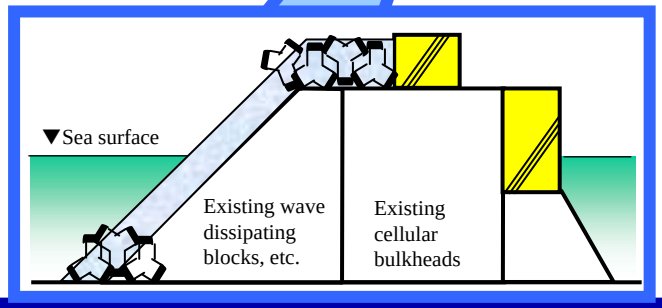
■ **Newly constructing an anti-seismic administrative building (FY2015)**



■ **Development of roads to access the power station (mid to long-term)**

■ **Enhancement of transmission lines**
(Response over the mid to long-term, such as by reconstruction, etc.)

■ **Raising the breakwaters (FY2013)**

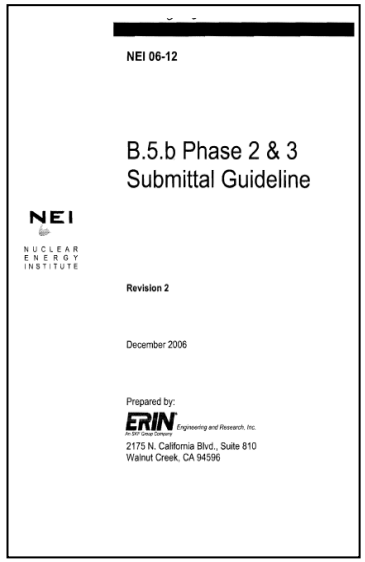


Height of breakwaters, etc.
- Drain pit: T.P.＋15m
- Breakwater: T.P.＋8m
- Periphery of the intake facilities: T.P.＋6m

Response to "B.5.b"(Extensive Damage Mitigation Guideline)

- Operators secured power source, ultimate heat sink (UHS) and SFP cooling by safety enhancement measures immediately after the accident.

- B.5.b is a clause in the NRC Order EA-02-026 , Order for Interim Safeguards and Security Compensatory Measures, which requires to adopt strategies to maintain or restore cooling and containment of the reactor core and spent fuel pool and to handle to extensive plant damage caused by explosions or fire.
- US industry guideline NEI 06-12, endorsed by the NRC, became publicly available after the Fukushima Daiichi accident.
- After the accident, US industry developed the diverse and flexible coping strategies (FLEX) implementation Guide, NEI 12-06, in response to extended loss of AC power (ELAP) and loss of UHS to secure mitigation capability.
- Japanese Utilities are currently taking necessary measures such as preparing operating procedures and equipments by using readily available safety enhancement measures and referring to the US industry guide/-lines, NEI 06-12 & NEI 12-06.


NEI 06-12

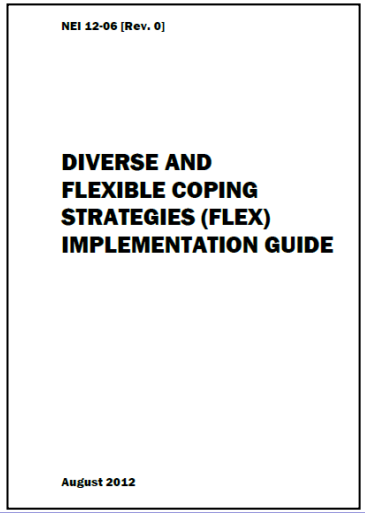
B.5.b Phase 2 & 3 Submittal Guideline

NEI NUCLEAR ENERGY INSTITUTE

Revision 2

December 2006

Prepared by:
ERIN Engineering and Research, Inc.
2175 N. California Blvd., Suite 810
Walnut Creek, CA 94596


NEI 12-06 [Rev. 0]

DIVERSE AND FLEXIBLE COPING STRATEGIES (FLEX) IMPLEMENTATION GUIDE

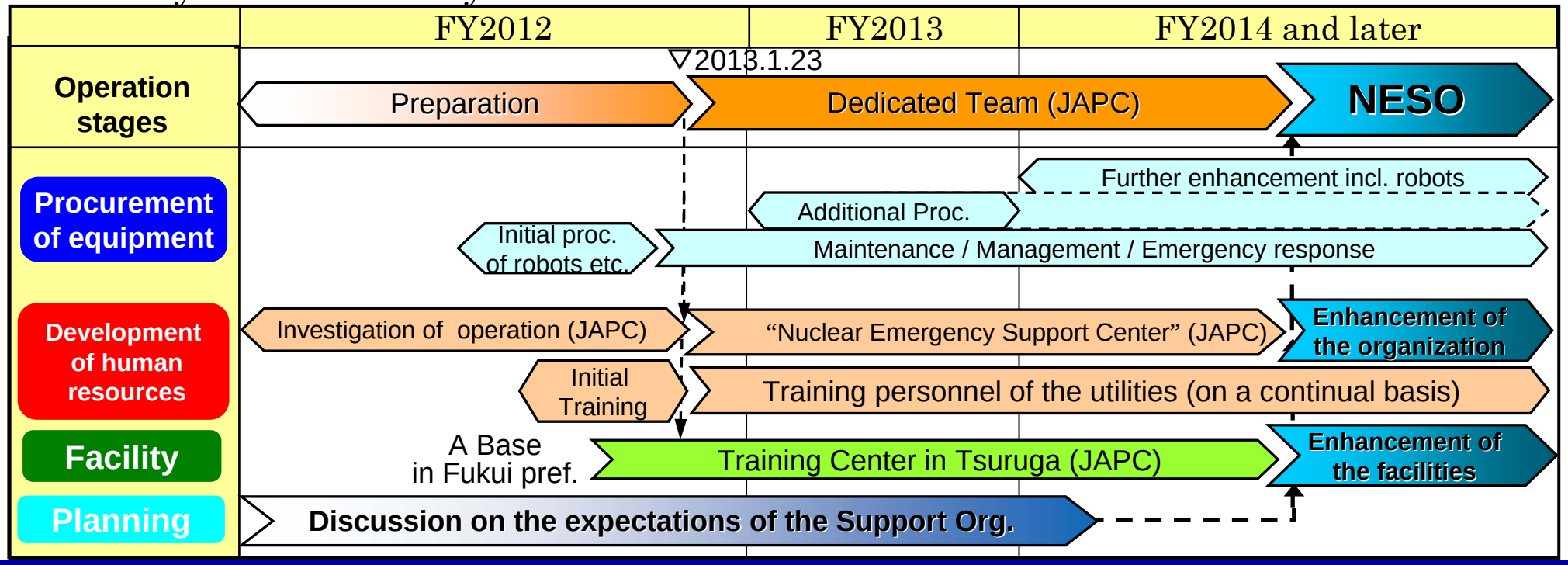
August 2012

The Nuclear Emergency Support Organization (NESO)

[Basic Role] NESO will be responsible for the integrated management and operation of materials and equipment. This will include remote-controlled robots that can be used in restoration efforts in high radiation dose environments, thus **minimizing workers' exposure**.

NESO will **assist the relevant electric companies** in reconnaissance on sites, measuring air dosage, removing debris, and other tasks.

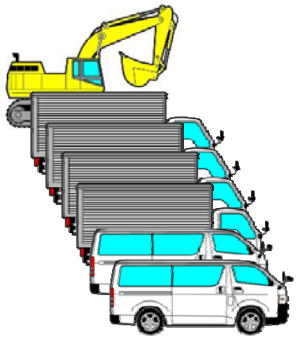
[Schedule] Operators intend to arrange this support system without delay and enhance the functions in stages, which aims at further enhancement of safety on a voluntary and continuous basis.



Operation of the Nuclear Emergency Support Organization (NESO)

NESO

[Normal Operation]



- ○Establishment of communication system in an emergency
- ○Operator training
- ○Maintenance & improvement of materials and equipment including robots

At call 24 hours a day /365 days

[In an emergency]

Affected Power Plant
Request for mobilization

NESO

Crew are collected

Mobilization preparation

Depart toward Power Plant

Delivery by NESO

Affected Power Plant

(Provisional)

[Inside or near reactor bld]

Removal of obstacles and debris by heavy machineries

Reconnaissance inside Bld/in the field by small Robots and small UAVs

Radio relay

[Low-dose area on site(off-site)]

Heavy machinery control vehicle

Robot control vehicle

Delivery

Designated Location near UPZ boundary

- ○Base for equipment and personnel
- ○Local command

Countermeasures Following the Items pointed out in the Various Investigation Reports of the Fukushima Accident

<Reports that were taken into consideration>

1. Final report of the government's "Nuclear Incident Investigation and Verification Committee looking into the crisis at the TEPCO Fukushima Nuclear Power Station" (published July 23, 2012)
2. Report of the Secretariat of the National Diet of Japan's "TEPCO Fukushima Nuclear Accident Independent Investigation Commission" (published July 5, 2012)
3. TEPCO "Fukushima Nuclear Accident Investigation Report" (published June 20, 2012)
4. Private investigation commission "Independent Investigation Commission on the Fukushima Daiichi Nuclear Accident Investigation and Verification Report" (published February 28, 2012)
5. INPO "Lessons Learned from the Nuclear Accident at the Fukushima Daiichi Nuclear Power Station" (published August, 2012)

The operators will take the reports seriously, and will respond in good faith after fully confirming its contents, by improving on their shortcomings, etc.

Steps taken for extracting the Lessons learned

So far

○Extracting the lessons learned at each Utility (For example KEPCO extracted 83 lessons-learned were extracted)

○All Utilities share their lessons-learned information

○Each utility checked whether the extracted lessons learned are enough

From now on

Continuously sharing the information related to the countermeasures and good practices

Further Promotion of Safety Enhancement Measures ~Establishment of JANSI~

Establishment of Japan Nuclear Safety Institute （JANSI）

In order to further enhance the safety of nuclear power stations, including the implementation of severe accident countermeasures, in light of the Fukushima accident of March 2011, the Japan Nuclear Technology Institute (JANTI) was dissolved, and JANSI was established on November 15, 2012 in order to lead the operators with the objective of achieving a higher level of safety.

Mission and activity points

In order to enhance the safety of the nuclear power stations, the operators must work on voluntarily and continuously enhancing safety by themselves and to constantly pursue the world's highest level of safety. In addition, a mechanism that prevents operators from becoming complacent and constantly evaluates these safety enhancement activities from a separate standpoint is necessary.

JANSI will establish an independent mechanism/system of technical evaluation that is not influenced by the operators' wishes in order to objectively evaluate and advise the operators as well as to raise the level of nuclear safety in Japan by supporting the operators' nuclear safety enhancement activities based on these evaluations.

Mission: To help Japanese utilities to pursue excellence in nuclear safety
~Tireless pursuit of excellence~

Scheme for Realizing Effectiveness of JANSI

① Independence in technical evaluation

<JANSI Chairman>

- Judgment regarding power station evaluation results
- Judgment regarding recommendations and advice

Recommendations and Advice by Chairman

<Committee of Operator CEOs>

- All power company CEOs participate
- Take place approximately four times per year

② CEOs Commitment

③ Coordination with International Organizations

<International Advisory Committee>

- Exchange views with CEOs of INPO, WANO, EDF, etc.

<Technology Evaluation Committee>

- Experts from inside and outside Japan make technical advices to JANSI Chairman

Efforts Aiming for the World's Highest Level of Safety

Together with JANSI, safety enhancement measures will be voluntarily and continuously implemented, with the aim of achieving the world's highest level of safety.

Enhancement of safety and reliability

Prevent core damage, etc., even in the event that the three functions (total AC power, sea water cooling function, spent fuel pool cooling function) were lost due to a tsunami exceeding the design basis, like what happened at the Fukushima Daiichi Nuclear Power Station

Quantitative verification using stress tests

World's highest level

・Incorporation of domestic and international good practices and new findings
(Led by JANSI)

Enhancement of safety measures

~Being proceeded voluntary~

○Shut down function
- Bolic acid injection by self-cooled injection pump

○Cooling function
- Enchancement of high-pressure injection function

○Confinement function
- Injection pump for containment vessel top head flange cooling
- Installation of a static catalytic hydrogen recombiner

○Supporting function
- Deployment of air-cooled emergency generators
- Provision of mobile DC supply equipment
- Provision of alternative UHS System (Vehicle-mounted UHSS alternative mobile sea water pump)
- Installation of filtered vent equipment
- Installation of an anti-seismic administrative building

Emergency safety measures

・Ensuring power source
Deployment of power-generating vehicles, etc.
・Ensuring cooling
Deployment of fire pumps, etc.
・Anti-inundation measures
Anti-inundation measures of switchboards, batteries, pumps

Pre-earthquake

Implementation of safety designs based on the design basis seismic motion and tsunami height, etc.

Emergency safety measures (April 2011) ▼

Stress test (July 2011~) ▼

Present ▼

New regulatory safety requirements Come into effect ▼

Thank you very much for your attention