Progress in TEPCO's Nuclear Reform

International Conference on Human and Organizational Aspects of Assuring Nuclear Safety – Exploring 30 Years of Safety Culture

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Tokyo Electric Power Company
Akira Kawano

Safety Measures at KK NPS based on Fukushima Accident (Hardware)

Fukushima Nuclear Accident

Large earthquake/tsunami occurs

Reflection: Weak tsunami protection

Station blackouts

Reflection: Alternative means to cope with station blackouts were not well prepared

Reactor building hydrogen explosions

Reflection: Insufficient preparedness to mitigate the repercussions of reactor core meltdowns

Facility-Related Measures

Preventing flooding caused by a tsunami

Sea wall

Watertight door

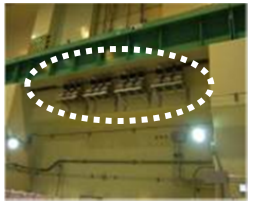
Diversifying power sources and water injection functions at high elevation

gas turbine generators

fire engines

reservoir

Mitigating the impact of severe accidents

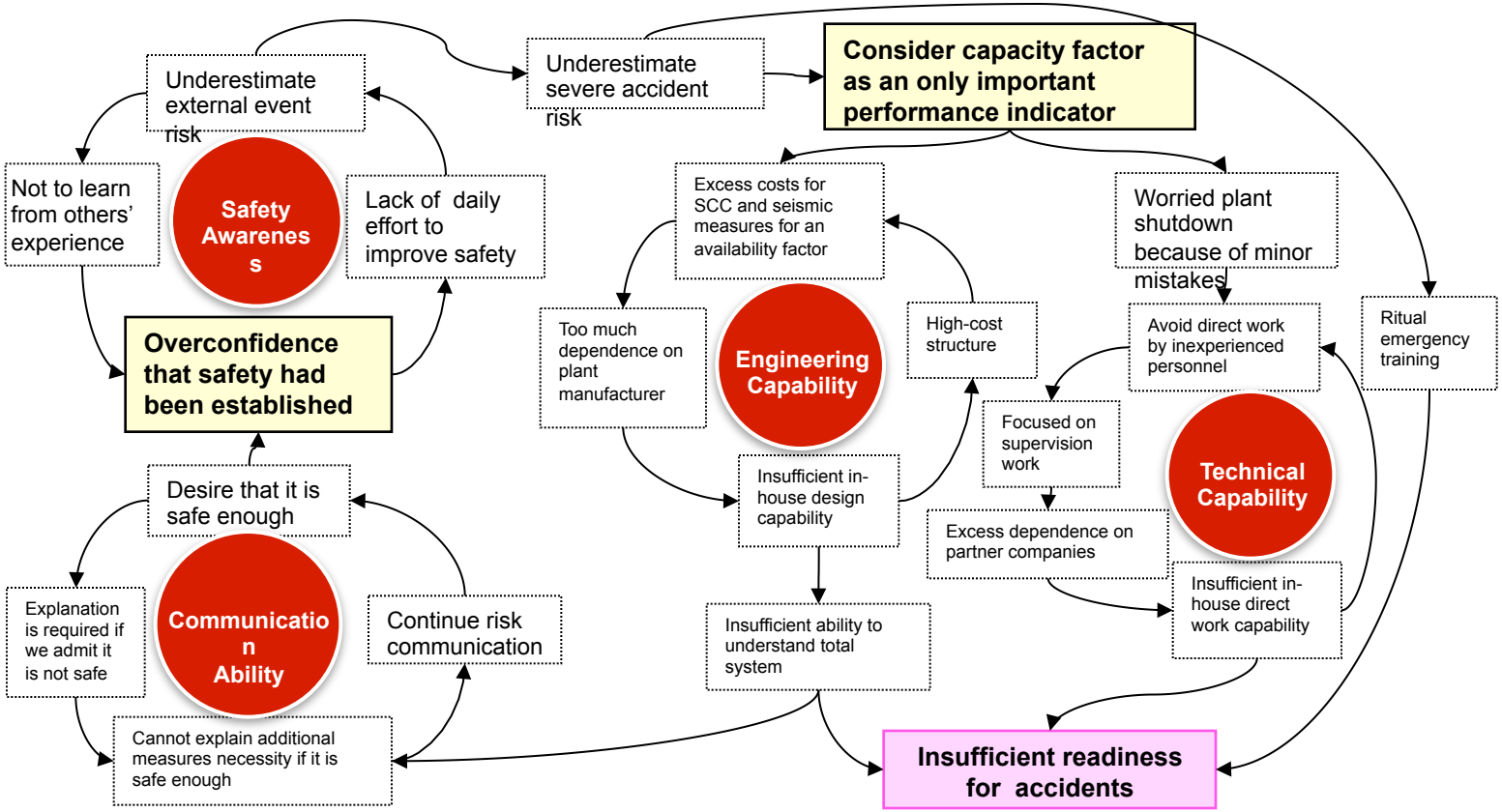


Installation of static catalyst recombiners

filtered-venting system

Negative Spiral of Insufficient Accident Preparedness (Software)

Negative linkage of the lack of “Safety awareness”, “Engineering capability” and “Communication ability” went into insufficient readiness for accident .



Reflecting back the 2000's

-TEPCO Scandal in 2002

-Discussion on Tsunami Estimation

TEPCO Scandal in 2002

Fact:

- Found Cracks/Indications in Core Internals and Recirculation System Piping, but NOT Reported to Regulator

- Intentionally Injected Air in the Containment Leakage Test

Cause:

- Lack of **"Reporting Culture"** and **"Nuclear Professionalism"**

based on **Production Oriented Culture** (Rather than Safety)

- Lack of **Oversight** Function and Weak **Governance** over the isolated functional groups (**Silos**) with **Complacency**

- Lack of **Safety Management System/Mechanism**, such as CAP, Safety Performance Review, Self-Assessment, etc.

- **Safety Culture** not yet permeated over the organization and not built into the processes, Ex. **Weak Questioning Attitude** and **Learning Culture**

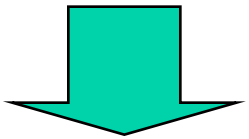
- Lack of Mechanism and Passion for **Pursuit of Excellence**

Countermeasures taken

Remedial Actions taken:

1. Oversight committee, in-house oversight group & corporate ethics committee
2. Organizational change: implemented and plans discussed by Managing Board

   (ex. Quality & Safety Group at each site, New Maintenance Department – responsible for all of planning, management, supervision and engineering)
3. Procedure/manual development meeting new QA structure
4. Ethics education and ethics hotline (in house): functional
5. CAP (Corrective Action Program): functional and “Passport” has been applied
6. Modernization of Maintenance Practices: RCM/CBM implemented on a part of equipments and evaluated



further improvement for Pursuit of Excellence

Nuclear Renaissance Activities

Nuclear Renaissance Activities for pursuit of Excellence

Since the TEPCO scandal in 2002

Benchmark Activities (Learning from the Best Practices)

Process Improvement (Core Activities: Implementation)

The reason why this activity was not fully successful was that:

- Sponsorship and Passion had not been shown continuously by top management
- Thorough focus on safety was not clearly demonstrated by top management
- Our people did not try to understand the values of standardization and commonality, rather stayed in their own silos.

Activities (Assessment – Self & External)

Activities: Training)

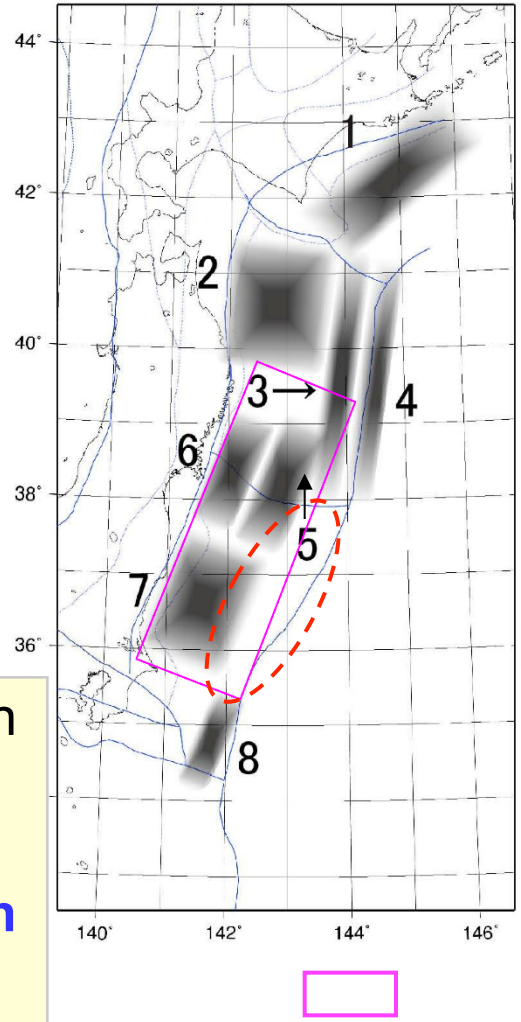
- LDE - LDE Overview

Learning and assessment for making changes

Implementing changes

JSCE Tsunami Assessment Method in 2002

No	Mw	Earthquake
1	8.2	1952 Nemuro-oki
2	8.4	1968 Tokachi-oki
3	8.3	1896 Meiji-Sanriku
4	8.6	1611 Keicho-Sanriku
5	8.2	1793 Miyagi-oki
6	7.7	1978 Miyagi-oki
7	7.9	1938 Fukushima-oki
8	8.1	1677 Enpo-Bousou



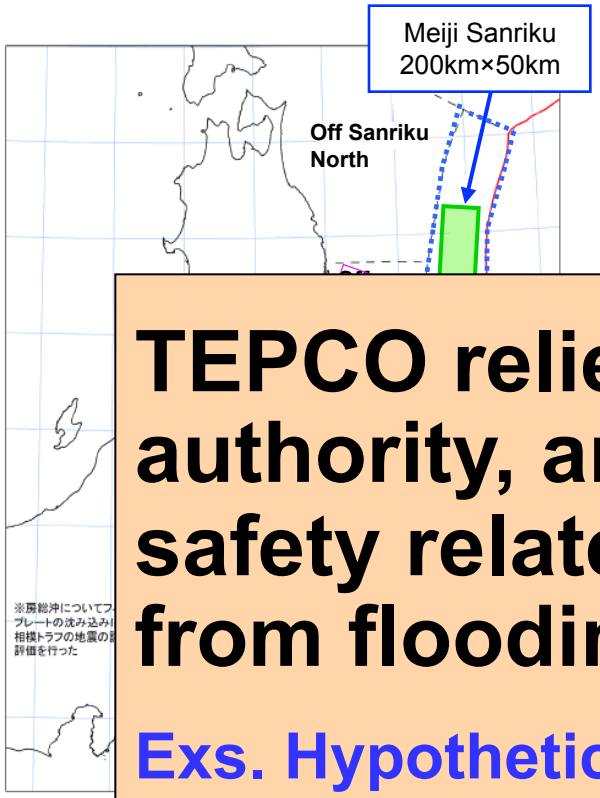
- Uncertainties, such as inexperienced event, are taken into account by **parametric study** of the standard fault model.
- **JSCE 2002 did not consider the tsunami source in the area along the trench of off the coast of Fukushima prefecture.**

Common Use of JSCE Method among Utilities

	TEPCO		JAPC	Tohoku EPCO
Event	Fukushima Daiichi	Fukushima Daini	Tokai Daini	Onagawa
Ground Level of main buildings	O.P.+10 or 13m	O.P.+12m	H.P.+8.9m	O.P.+14.8m
Establishment Permit	Unit 1 in 1966 O.P.+3.122m	Unit 1in 1972 O.P.+3.122m Unit 3/4 in 1978 O.P.+3.705	— in 1971	Unit 1 in 1970 O.P.+2～3m (Literature Suevey) Unit 2 in 1987 O.P.+9.1m (Numerical Simulation)
JSCE Method in 2002	O.P.+5.7m (Tsunami off the coast of Fukushima is dominant.)	O.P.+5.2m	T.P.+4.88m	O.P.+13.6m (Tsunami off the coast of Sanriku is dominant.)
Scen disast pub prefe	Countermeasure such as raise of the seawater	Countermeasure such as making the buildings	Countermeasure was	Countermeasure was
Sce disas publis prefe				
Latest bathymetric and tidal data in 2009	O.P.+.6.1m Countermeasure such as raise of the seawater pumps was completed.	O.P.+.5.0m Countermeasure was unnecessary.	unexplained	unexplained
Tsunami in 2011	O.P.+13.1m (Tsunami height) O.P.+15.5m Inundation height)	O.P.+9.1m (Tsunami height) O.P.+14.5m Inundation height)	T.P.+5.4m	O.P.+13.8m

TEPCO was relatively comfortable with the commonly used methodology among all the utilities.

Trial Calculation in the Light of HERP in 2008



- The Headquarters for Earthquake Research Promotion **(HERP)** proposed in 2002 that **there is a possibility that M8.2 earthquake could occur anywhere along the Japan Trench.**
- **TEPCO carried out a trial calculation in a**

TEPCO relied too much on the outside authority, and lost chances to protect safety related components/systems from flooding by themselves.

Exs. Hypothetical Calculations, Sumatra Tsunami, Okushiri Tsunami etc.

Fig. E
H
R

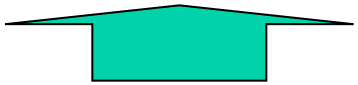
Touch in the materials by HERP, 2002

	2F				
unit	1	2	3	4	(O.P.12m)
Tsunami Hight [m]	7.6	7.2	7.8	8.2	15.5(Southern part)

Run-up Height

Background of Missed Opportunity

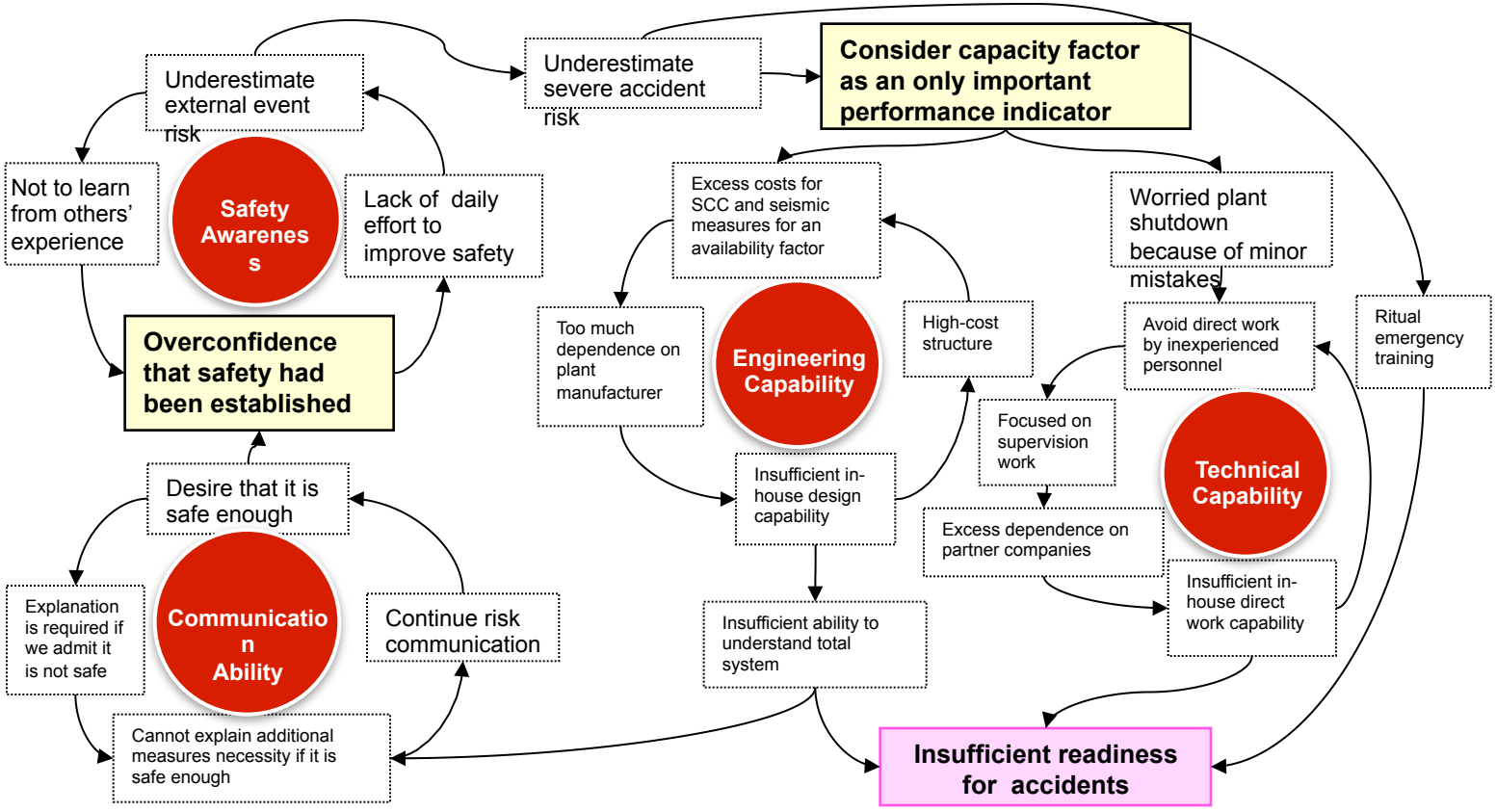
- Counted 'probability' rather than 'consequence'
- Silo – did not promote cross-functional discussions among associated organizations, civil engineering was a sort of isolated area not to be challenged
- Insufficient Learning Culture – Ex. what we learned from the flooding event at Blayais NPS, France
- Lack of Self-Independent and Proactive Thinking – lost an opportunity to take an temporary safety enhancement measures



✓TEPCO believed that severe accident was unlikely then it was not necessary to improve safety measures more, at least immediately (putting off the decision), that could be closely associated with Japanese National Culture 2.

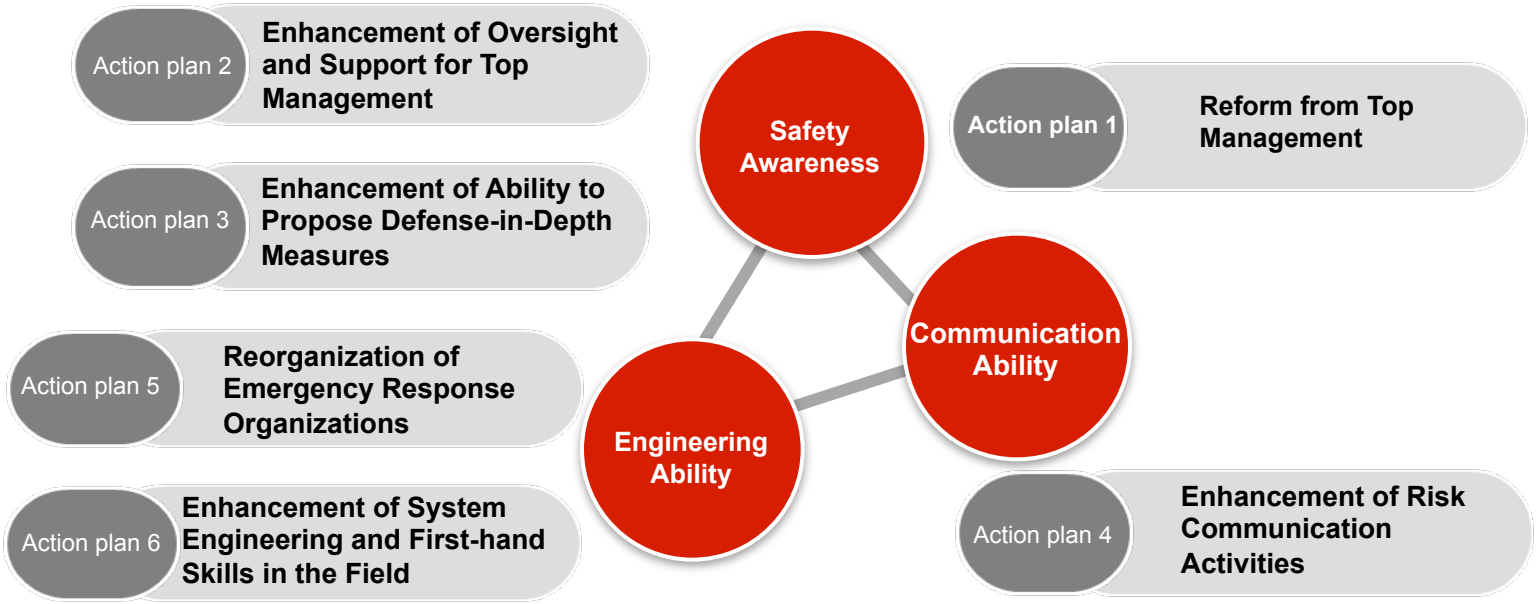
Negative Spiral of Insufficient Accident Preparedness (Software)

Negative linkage of the lack of “Safety awareness”, “Engineering capability” and “Communication ability” went into insufficient readiness for accident .



Nuclear Safety Reform Plan

"Reflection of Fukushima Nuclear Accident and Nuclear Safety Reform Plan" was issued on March 29, 2013. It contains six action plans.



Our Determination

Improve safety level day by day reflecting the experience of Fukushima Nuclear Accident and **be a nuclear operator who can continuously create supreme safety.**

Action Plan1: Reform from Top Management – Training and Learning to Improve Safety Awareness of Top Management

- Top managements must thoroughly
  - **recognize unique risks** of nuclear power
  - **understand** that a nuclear power operator has **the primary responsibility on safety**
  - **strengthen leadership** to improve safety awareness of the entire organization and make efforts for human resource development.
- **Training course for top management** has been introduced to improve safety awareness.
- Nuclear leaders should learn from good practices of others.

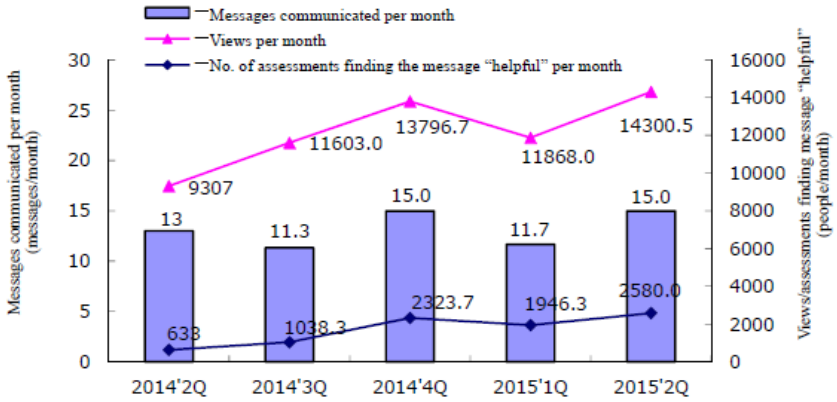
Training for top managements to analyze and examine Fukushima nuclear accident to improve safety awareness

Exchanging ideas about fostering leaders and building teamwork at Exelon Corporation

Action Plan1: Reform from Top Management – Management Walk Down and Communication to Demonstrate Leadership

- **Nuclear Leaders make management walk down whenever possible** to talk with people at the site and understand the status of working field and facilities by themselves.
- **Nuclear Leaders send safety messages to all members** to clarify their expectations and to demonstrate behaviors of good nuclear safety culture through direct talk, video, intra-net, e-mail.

Power station safety inspection undertaken by executives

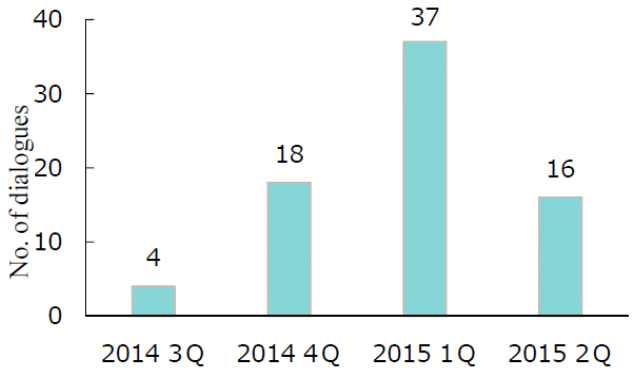


Number of nuclear leader intranet messages communicated & viewed/number of assessments finding message "valuable" (monthly averages)

Action Plan1: Reform from Top Management - Recognition of Good Performance and Understanding of People's Thoughts

- From FY2015 Q1, Awards are given to employees who implemented valuable initiatives.
- The CNO has been continuously conducting a direct dialogue with managers and other employees since February 2014.

CNO Awards Ceremony



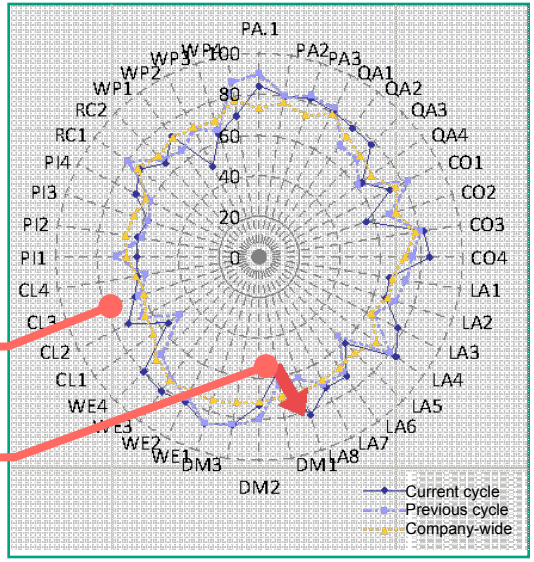
Number of direct dialogues between CNO and people at the site

Action Plan1: Reform from Top Management - Enhancement of Safety Culture

- All members of nuclear division review one of 10 traits of a healthy nuclear culture every day.
- The practice rate, which was 70% when the activity began, is currently maintained at over 90%, which demonstrates that this measure has taken root.

10 Traits of a healthy nuclear safety culture

Self-evaluation of 10 traits and 40 behaviors



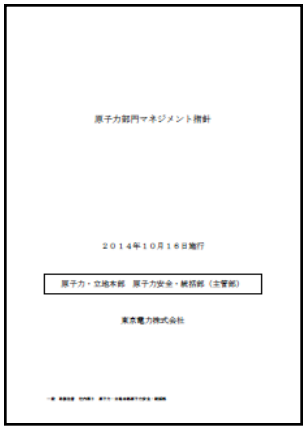
If the result has not changed from the previous one after a certain special event, evaluations must be investigated.

When current evaluation result is significantly different from previous one, events occurred during the evaluation period will be checked.

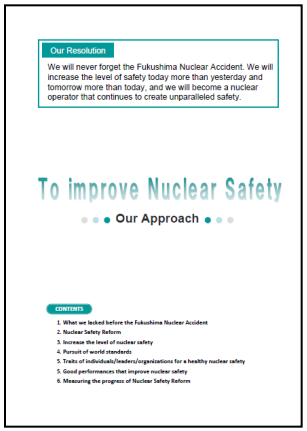
Action Plan1: Reform from top management – Development of Robust Management Model

- Nuclear Power Division Management Policy (NPDMP) was developed to clarify the expectations of nuclear leaders and to improve work processes based on it.
- The Booklet “To Improve Nuclear Safety” Summarizing NPDMP was developed to communicate the followings throughout Nuclear Power Division;
  - lessons learned from Fukushima Accident
  - importance of the nuclear safety reform
  - framework of management for safety reform

Briefing session of NPDMP



NPDMP



Booklet “To improve Nuclear Safety”

Action Plan1: Reform from top management – Monitoring Performance by redeveloped KPI

- "Nuclear Safety KPIs" were redeveloped to monitor the progress in our challenges to improve nuclear safety and performance.

Result Level		Fukushima Daiichi	Fukushima Daini / Kashiwazaki-Kariwa
No release of / no exposure to radioactive materials under normal conditions	Plant workers* are protected from being exposed to radioactive materials.	• Total exposed dose of entire workforce	• Total radiation dose exposure of workforce
	Steady release of radioactive waste is under control	• Site boundary radiation dose • Stored amount of contaminated water • Stored waste amount • Radioactive release amount into the atmosphere • Leakage events number of contaminated water • Cesium level in the seawater in/outside the port	• Release amount of gaseous and liquid waste • Stored waste amount
No release of radioactive materials due to an accident	No abnormality (initiating event) occurs.	• Safety equipment: – Number of unplanned activation of emergency devices – Number of unplanned shut-downs • Unplanned parameter variation • Number of fire occurrences	• Number of unplanned activation of safety systems • Number of scrams • Unplanned power variation • Number of fire occurrences
	Abnormality mitigation measures are sufficient.	• Safety equipment: – Number of emergency devices failures – Non-standby rate • Number of LCO deviations • Risk indexes	• Number of failures of safety devices • Non-standby rate of safety systems • Number of LCO deviations • Risk indexes

Action Plan1: Reform from top management – Mechanism of Continuous Improvement

- 22 CFAMs (Corporate Functional Area Managers) are assigned.
- CFAMs lead and establish world class excellence in their assigned functional area using their expertise and collecting best knowledge in the world.

Areas that CFAMs to be assigned and standards to be met

CFAM areas <conventional functions (example)>	Standards to be met (PO&C)
Operation	OP, OF
Maintenance, incl. Work Control	MA, WM, PM
Equipment Reliability	ER
Design Control and Configuration Management	EN, CM
Radiological Protection/ Radiation Exposure Control	RP, RS
Radioactive Waste Management (Gas, Liquid, Solid)	CY.1/3, RP.1,
Fuel Management	FA, CM.4

CFAM areas ＜focus area（example）＞	Standards to be met (PO&C)
Fire Protection	FP.1
Physical Protection (including cyber-terrorism)	-
Industrial Safety	IS
Safety Engineering	OR.3
Operational Experience / Corrective Action Program	OE.1
Education / Training	TR.1, OR.4, CO.6
Safety Culture	-
Emergency Preparedness	EP

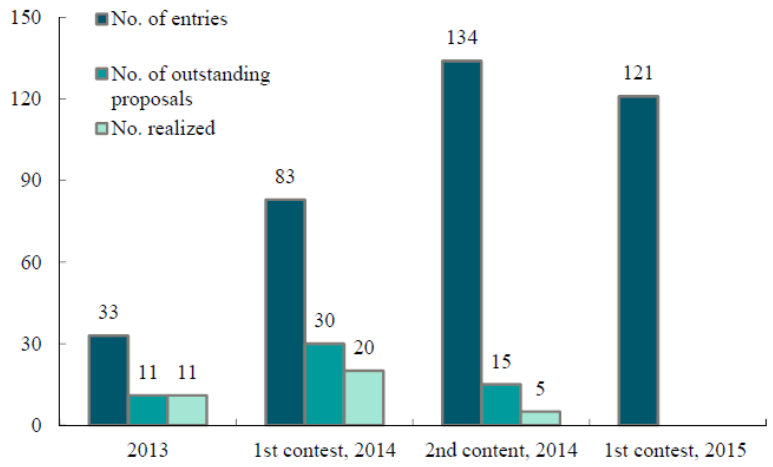
Action Plan2: Oversight and Support for Top Management

- **The Nuclear Safety Oversight Office** (NSOO) was established in May 2013, and is continuously providing the line organization with safety critical recommendations and suggestions so that TEPCO could be one of the safest nuclear operators. The areas the NSOO is now focusing on are as follows:
  - 1F: Control of Contractors, Thorough Implementation of ALARA, Safety Management in various Projects, Proper Evaluation and Control of Nuclear Risk
  - KK: Readiness of Operators at Unit 6/7, Nuclear Safety Focus based on the Cable Installation Issue
  - HQ: Initiatives associated with Nuclear Safety Management

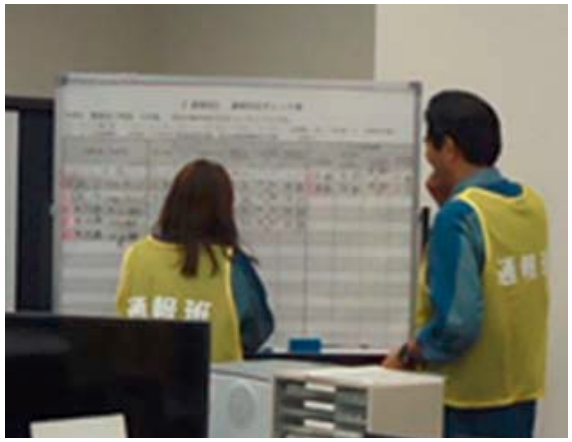
Meeting with overseas advisors

Action Plan3: Strengthening the ability to propose Defense In Depth (DID) - Competition on Safety Improvement Proposals

- Daily review and discussion of international OE information to withdraw prompt safety measures from them.
- Competitions are held twice in a year to strengthen DID safety measure proposal. In the competition, all employees can raise concerns about vulnerability of facilities and operational risks and propose any kind of safety enhancement.



Number of Safety Improvement Proposal Competition entries, outstanding proposals and proposals realized



Whiteboard being used during emergency training (Fukushima Daini NPS)

Action Plan3: Strengthening the ability to propose DID - Hazard Analysis

- Examination of hazards which may cause a severe accident resulting in a comprehensive function loss of safety features due to common mode failure.
- 30 hazards have been examined including events whose probabilities are not well estimated.
- Pursue the best measure to prevent huge influence of core damage and emission of radioactive materials to the environment.

Tornado beyond F3 level

Poisonous Gas

Impact of Meteor

Terrorism using airplane attack

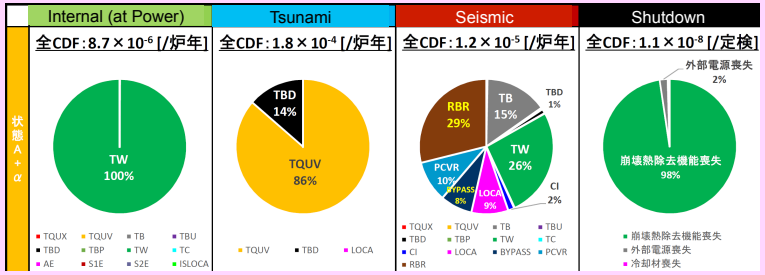
Volcanic Eruption

Action Plan3: Strengthening the ability to propose DID – Practical Use of PRA

- Decision making using risk information such as PRA (Probability Risk Analysis)

Vulnerability identification, Plant modifications, Evaluation of risk reduction effectiveness

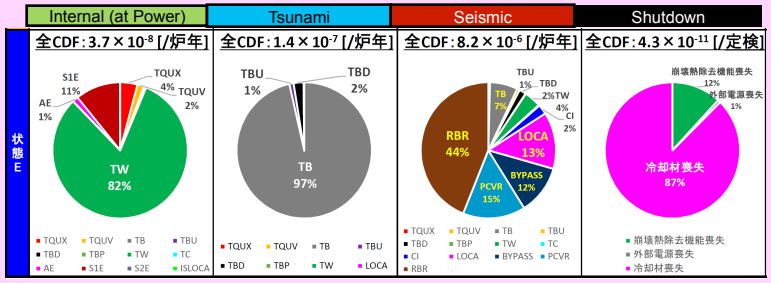
Before measures



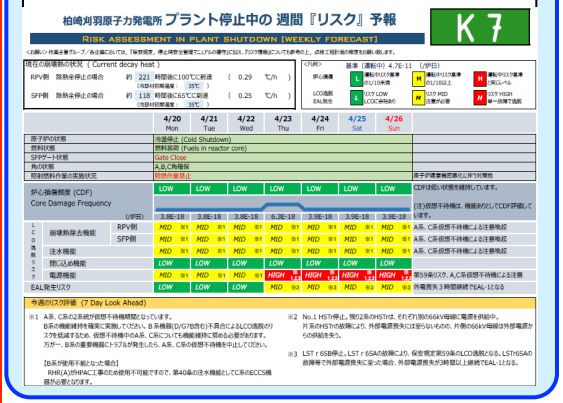
Measurements

GTG vehicle etc.

After measures

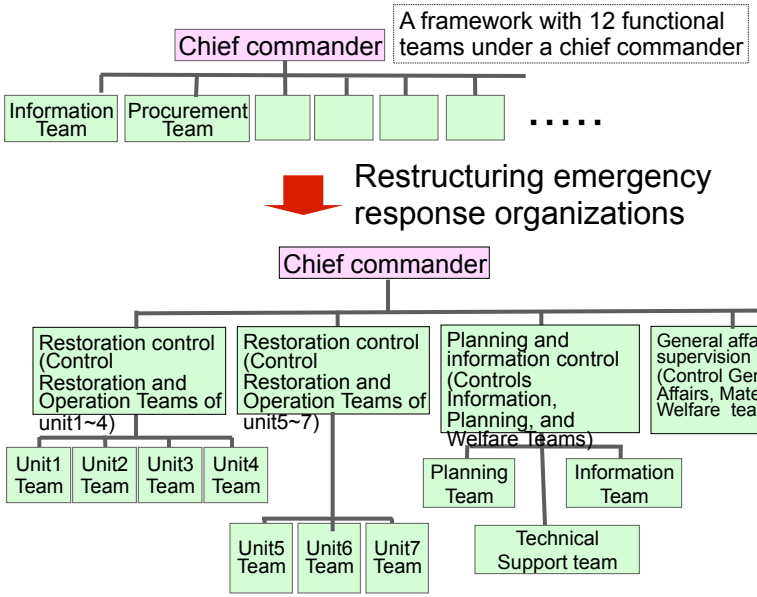


Configuration management
-Example of risk monitoring at outage



Action Plan5: Strengthen emergency response capabilities – ICS and Reorganization of Emergency Response

- TEPCO introduced Incident Command System (ICS), the most advanced emergency response framework, to the Site and the Headquarters, and restructuring emergency response organization was made. The ICS has the following features:
  - Structured with the commander at the top and 3-7 direct subordinates
  - Clear command system in which only the orders of direct superiors are followed
  - Use of forms and tools for efficient information sharing at all organizational levels
- Refining the skills of workers to restore equipment and operate heavy machinery, and participating in joint training with the local government.



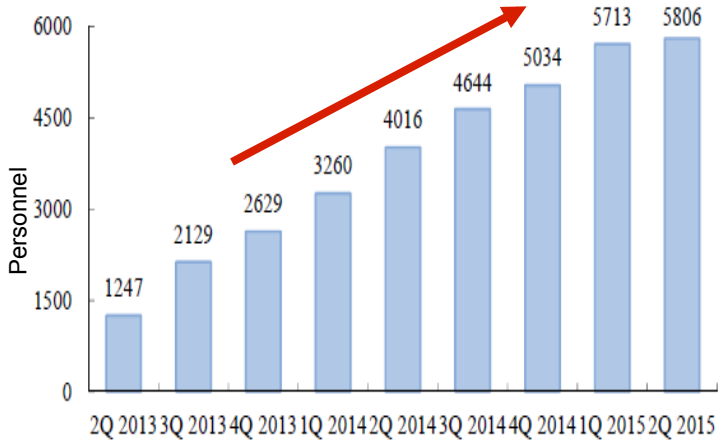
Restructuring emergency response organization

Training at a rear logistics base (J-Village)

Photo of emergency drill at KK

Action Plan6: Strengthen Engineering and Technical Capabilities

- Skills to restore facilities and control heavy equipment are being trained and enhanced to become a power station that can cope with circumstances where there is little hope for assistance on restoration.
- Operator skills are observed and coached by overseas experts.
- System Engineering group was established and their capabilities are being continuously trained.



Number of individuals attending the training for directly managing work at Kashiwazaki Kariwa NPP

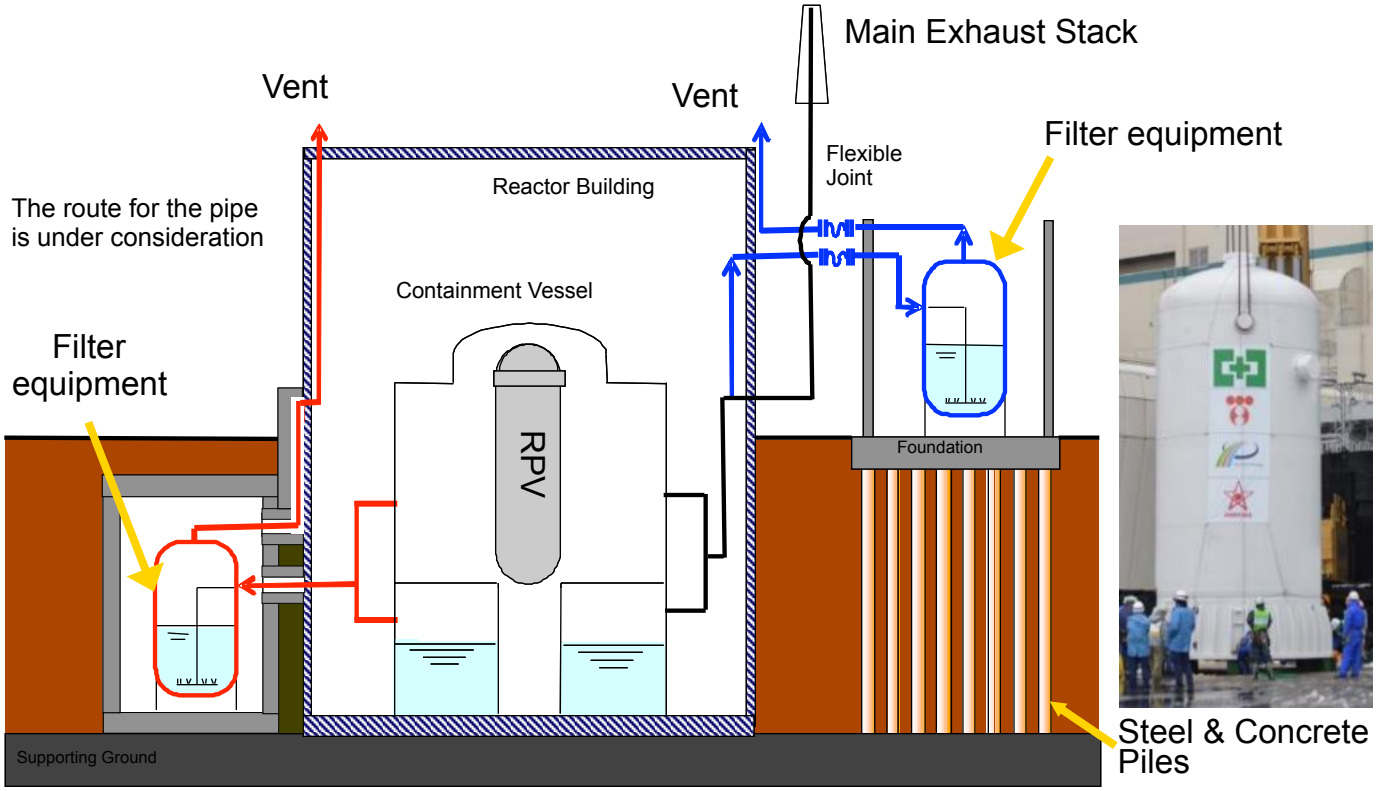
Training in connecting temporary hoses

Debris removal

Observation of operators by overseas experts (Kashiwazaki-Kariwa NPS)

Action Plan6: Strengthening Engineering Capability

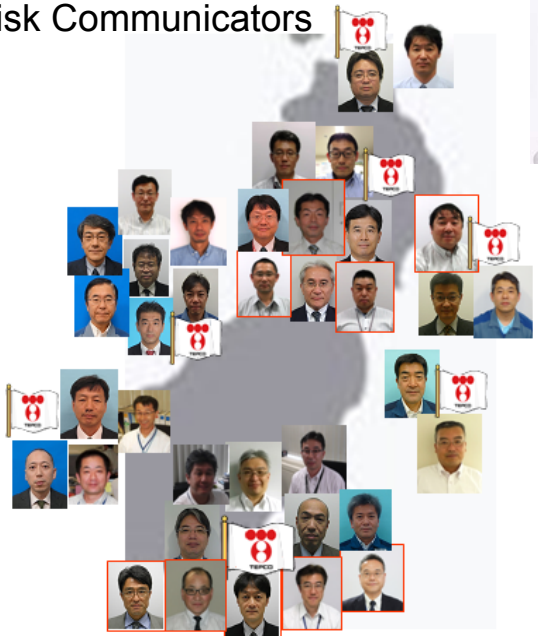
- For strengthening engineering capability, TEPCO independently designed and supplied Filtered Venting System without plant manufacturers' support.
- TEPCO was able to complete FV system with huge cost reduction for a short term.

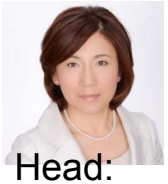


Action Plan4: Improve risk communication performance

- In April 2013, TEPCO set up the **Social Communication Office** and invited an external personnel as the head of the Office (January 2014).
- The Office was expected to bridge the gap between TEPCO's approaches and social standards, and also to actively disclose information.
- TEPCO deployed “risk communicators (RC)” to the Headquarters and power stations.

Risk Communicators





Head: Ms.Chisa Enomoto

Easy-to-understand explanation with CG

Presentation to the local residents in Fukushima

The Number of Risk Communicators

@Fukushima	16
@Niigata	11
@Aomori	2
@Headquarters	11
Total	37

Presentation at an Embassy in Tokyo

For Further Improvement of Nuclear Safety and Safety Culture

- Continuously Improve Safety Awareness of Top and Middle Management
- Redevelop the Training and Education Program
- Improve the Corrective Action Program for Effective Learning
- Reinforce Fundamental Attitude and Behavior in individual functional areas
- Establish the Robust Engineering Organization

Lastly I would like to introduce the current situation at Fukushima Daiichi NPS !!