

**Summary and Analysis of the Fukushima Nuclear Accident**

- [Analysis]**
- Insufficient consideration was given to malfunctions caused by common factors resulting from external events (earthquakes and tsunamis), and as a result a total loss of AC power occurred.
  - There were insufficient efforts to continually reduce risk by gathering and analyzing OE information and the latest technological know-how.
  - Communications activities in general were neither swift nor accurate.
- [Summary]**
- TEPCO concluded that the root cause of these circumstances can be attributed to **insufficient accident preparedness resulting from a lack of company-wide “Safety Awareness”, “Technological Capability”, and the “Dialogue-Promoting Capability”**.
  - **The Fukushima Nuclear Accident should not be brushed aside as a consequence of a natural disaster while inferring the difficulty to predict large-scale tsunamis. Rather, the accident should be treated as the result of the failure to prevent events that should have been addressed far prior to the disaster as part of intelligently thought out accident preparedness.**
  - Operators responsible for facilities that have unique risks, such as nuclear power plants, **must have a level of safety awareness that far exceeds other industries. In addition, they must build upon this foundation and incorporate OE information and technical advances from all over the world, refine and hone technical skills and strive to reduce risk on a daily basis.**

**Moving Forward with the Nuclear Safety Reform Plan**

- TEPCO is determined to become **“a nuclear operator that continuously improves safety to unrivaled levels by enhancing safety levels on a daily basis while always keeping the Fukushima Nuclear Accident in mind”**. To this end, the company has been moving forward with the Nuclear Safety Reform Plan since April 2013.
- Reviews by the IAEA, WANO, INPO and the Nuclear Reform Monitoring Committee, which is comprised of experts from Japan and overseas, shall be proactively implemented at a greater frequency, and the issues pointed out and suggestions given shall be handled in earnest.

	Before	After
 <p>Safety Awareness</p>	<ul style="list-style-type: none"> <li>● <b>Complacency about nuclear safety within the company</b> <ul style="list-style-type: none"> <li>✓ Management took nuclear safety for granted and did not conduct company-wide activities to boost safety levels.</li> <li>✓ Management attributed the cause of accidents and troubles in the Nuclear Power Division to incompetency in the field.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>● <b>Upper management and Nuclear Power Division executives have increased their own safety awareness and nuclear safety culture is permeating throughout the organization</b> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Upper management analyzes and examines the Fukushima nuclear accident in order to increase their safety awareness</p> <p>[Upper management and Nuclear Power Division executives have taken part in such discussions 30 times]</p> </div> <div style="text-align: center;">  <p>Opinion exchange session at the Quad Cities Generating Station in the United States</p> </div> <div style="text-align: center;">  <p>Nuclear Power Division executives examine and incorporate best practices from overseas</p> <p>[Visits to three power stations overseas were made during FY2014]</p> </div> </div> <div style="text-align: right; margin-top: 10px;"> <p>Middle management has been subjected to safe work management (Training Within Industry (TWI)) training</p> <p>Driving home the mindset that “an employee not being able to do something is the fault of his/her supervisor”.</p> <p>[Approximately 250 participants]</p> </div> </li> </ul>
 <p>Technological Capability</p>	<ul style="list-style-type: none"> <li>● <b>Only minimum safety measures conducted</b> <ul style="list-style-type: none"> <li>✓ TEPCO did not actively gather or analyze domestic and international information on safety, and only implemented measures required by rules and regulations.</li> </ul> </li> <li>● <b>Lack of ability to respond independently to emergencies</b> <ul style="list-style-type: none"> <li>✓ Emergency response training had lost substance thereby resulting in a confused chain of command when the accident occurred.</li> <li>✓ TEPCO was only able to respond to accidents to a limited degree without outside assistance.</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>● <b>Efforts are being made to not just stop after fulfilling regulatory requirements in regard to safety measures, but rather independently identify issues, proactively propose countermeasures to improve safety and bring those countermeasures to fruition</b> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Gathering and analyzing OE information (accidents/troubles) from other countries.</p> <p>[682 cases analyzed in two years]</p> </div> <div style="text-align: center;">  <p>Emergency response trucks kept onsite and communication methods enhanced</p> </div> </div> <p>The OE calendar created by the INPO is checked daily</p> <p>Taking the initiative to independently identify issues and quickly make improvements [Competition to enhance the ability to make safety improvement-related suggestions: 250 proposals made over two years, 56 were employed]</p> </li> <li>● <b>TEPCO can now handle an accident without outside assistance for as long as 72 hours</b> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;">  <p>Fire trucks and wheel loaders, etc., are now onsite to enable TEPCO to handle an accident without outside assistance for as long as 72 hours after it occurs, and workers are trained how to use the equipment.</p> <p>[4640 training sessions (Kashiwazaki-Kariwa)]</p> </div> <div style="text-align: center;">  <p>All personnel participate in emergency response training and the training scenarios are not conveyed in advance.</p> <p>[Increased from once a year to once and month (Kashiwazaki-Kariwa)]</p> </div> </div> </li> </ul>
 <p>Dialogue-Promoting Capability</p>	<ul style="list-style-type: none"> <li>● <b>Deviation from social standards</b> <ul style="list-style-type: none"> <li>✓ The mindset and priorities of the Nuclear Power Division differed from that of society.</li> </ul> </li> <li>● <b>A myth of infallible safety had been created both within and outside the company</b> <ul style="list-style-type: none"> <li>✓ TEPCO had a strong belief in its infallible safety (i.e., zero-risk), and was reluctant to actively disclose risk information</li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>● <b>Social Communication (SC) Office created along with the position of Risk Communicator (RC) in order to promote communication that cultivates trust</b> <p>Nuclear engineers dispatched as RC. RCs participate in training conducted by external experts.</p> <p>[Number of RCs: 37 at current time]</p> <div style="text-align: center;">  </div> </li> <li>● <b>Continual dissemination of information in an easy-to-understand manner</b> <p>Information is being proactively provided to other countries by inviting foreign dignitaries to visit the power station and observe emergency response training, and visiting foreign embassies in Japan to give direct explanations.</p> <p>[A total of approximately 69 representatives from foreign embassies in Japan have toured the facility on four occasions (FY2014)]</p> <div style="text-align: right; margin-top: 10px;">  <p>Representatives from foreign embassies in Japan observing emergency response training (Eight representatives of seven countries)</p> </div> </li> </ul>

## Reflecting on the Fukushima Nuclear Accident

### Large earthquake/tsunami occurs



**Reflection:** Weak tsunami protection

### Station blackouts



**Reflection:** Alternative means to cope with station blackouts were not fully 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

**Measure:** Kashiwazaki-Kariwa (KK) installed a 15-meter sea wall even though the maximum height of predicted tsunamis is 6-meters. Watertight doors were installed to prevent flooding in areas with power sources and important equipment.



- ✓ Sea wall (15m high despite maximum tsunami height prediction of 6m) fabrication (Prevents flooding of the station site by a tsunami)
- ✓ Design basis seismic ground motion also considered in view of interlocked movement of active faults



- ✓ Watertight door installation (Prevents flooding of rooms that house important equipment)

### Diversifying power sources and cooling water injection functions

**Measure:** KK now has power supply cars on site to prepare for a lack of access to emergency power sources. The station has also secured cooling water by building a reservoir on elevated ground.



- ✓ Deploying gas turbine generator cars and fire engines (Enables power to be secured in the event of a lack of access to the station's emergency power sources)



- ✓ Building a reservoir (Securing a water source for cooling reactors in emergencies)

### Mitigating the impact of severe accidents

**Measure:** KK has altered facilities to reduce the discharge of radioactive materials after reactor core meltdowns



- ✓ Installation of static catalyst recombiners (This equipment recombines the hydrogen leaked from PCVs, and reduces hydrogen concentrations)



- ✓ Installing filtered-vent facilities (This facility cuts down radioactive cesium to levels at 1/1000 or below when there is a need to externally release steam or hydrogen)

## Operational Measures

### Strengthening emergency response capabilities

- KK set up an ICS to specify the chain of command, and has been repeatedly conducting trainings assuming emergencies (i.e. individual trainings in response to roles, comprehensive trainings either jointly performed between the Headquarters and power stations, or conducted station-wide).



**Number of comprehensive trainings conducted at KK:**

**20**

- ✓ Comprehensive training (KK's Emergency Response Center)

**Number of individual trainings conducted at KK:**

**4,640**



- ✓ Joint training with the Kashiwazaki city fire department to transport injured individuals

**Strengthening "Safety Awareness", "Technological Capability", and the "Dialogue-Promoting Capability" through trainings**

Safety Awareness

- Reflecting on predetermined and hollowed-out previous trainings, KK has been repeatedly conducting blind trainings that do not reveal its scenarios in advance, or trainings that assume unprecedented risks such as tornadoes.

Technological Capability

- Reflecting on excessive reliance on station manufacturers or contractors, KK has secured technological capabilities to take action for 72 hours without external assistance, by having its employees acquire skills to restore facilities and control heavy equipment.

Dialogue-Promoting Capability

- Reflecting on the communications shortcomings after the Fukushima accident, KK has been conducting training that incorporates mock press conferences and external responses.

Examples

**Applying improved training outcomes to daily operations**

- KK is employing a phonetic system in all situations, which helps prevent miscommunications.
- KK is employing tools to share information (e.g. tablets) in non-emergency operations as well. These tools are usually carried by personnel dispatched to local governments in the wake of accidents.

## Improving Safety Awareness

### Measure1 : Reform from top management

#### - Commitment of the management -

- Management and nuclear power leadership are now regularly providing nuclear safety-related past events they encountered or cases experienced at other companies (safety minutes) at the beginning of meetings. They also visit the field whenever possible, be it weekdays or weekends, to speak with members and check the field and facilities first-hand.



✓ Power station safety inspection undertaken by executives

#### - A nuclear safety culture for each and every member -

- All Nuclear Power Division members under the General Manager of Nuclear Power and Plant Siting Division make efforts to review the 10 particulars given on the right, even if it may be for a short amount of time.
- Members make steady efforts to raise safety levels starting from daily attributes, instead of only nuclear safety-related issues. Examples include the consistent use of the handrails while descending stairways, undertaking pointing-and-naming procedures at on-site crosswalks to make sure that the streets are clear, and always fastening safety belts when entering the field.

#### ✓ 10 Traits for all members to review their attributes everyday

Commitment by members	1. All members will take responsibility for nuclear safety.
	2. All members will constantly question and pursue nuclear safety
	3. All members will communicate with a focus on nuclear safety
Commitment by leaders	4. Leaders will demonstrate their commitment to nuclear safety by their own decision-making and attributes
	5. Leaders will make decisions associated with nuclear safety upon exhaustively considering every risk and option in a systematic and detailed manner.
	6. Leaders will foster an organizational climate where leaders and staff have a respect for each other, value different opinions, and engage in their operations upon mutual trust.
Commitment by the organization	7. The organization will search for opportunities to study nuclear safety both within and outside the company, feed its learnings into the organization, and apply them.
	8. The organization will swiftly specify issues that may influence nuclear safety, and take effective and remedial actions without delay.
	9. The organization will develop a framework where all individuals can openly express concerns on nuclear safety and present issues.
	10. The organization will plan and control all operational processes upon placing top priority on nuclear safety

- ✓ Laying out Traits of individuals/leaders/organizations to ensure a healthy nuclear safety



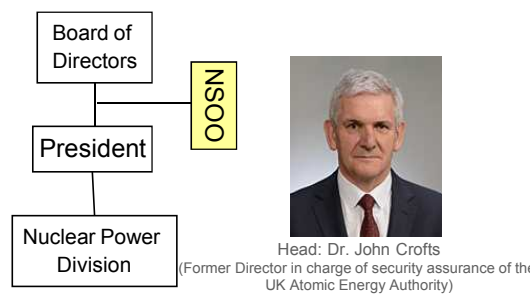
#### - Monitoring Safety Awareness and attributes to strive to discuss about issues and improvements -

- TEPCO initiated monitoring upon designing an indicator to quantitatively measure Safety Awareness or attributes (KPI). Efforts are being made to invite all personnel levels, spanning from management, nuclear power leadership, to field members, to routinely discuss on issues and improvements.

### Measure2 : Strengthening observation and assistance for management

#### - Improving the Nuclear Power Division's governance -

- TEPCO established the Nuclear Safety Oversight Office in May 2013 under direct control of the Board of Directors. Dr. John Crofts, an overseas nuclear safety expert, was invited to head the Office.
- The Office directly and independently observes the Nuclear Power Division, reports on observation outcomes, and issues proposals to the Board of Directors. Based on this report, the Board of Directors instructs to make improvements to operating divisions and checks the progress of the improvements, thereby working to enhance the governance of the Nuclear Power Division.



✓ Establishment of the Nuclear Safety Oversight Office

## Issues and Future Activities

### Issues:

- The recent serious accidents and the problem on information disclosure associated with contaminated suggest that senior management and nuclear leaders have not fully penetrated the entire organization with the new safety culture, and that middle managers have been unable to actualize it.

### Future Activities:

- Management and nuclear power leadership will reinforce a questioning attitude towards nuclear safety culture (actively taking the lead and setting an example)
- Management and nuclear power leadership will constantly question the status of the field to encourage middle management to reshape their mindset and actions
- Several steps will be harnessed instead of relying on one, to make a change in middle management and to thereby achieve improvements

## Goals

- Have the management and nuclear power leadership demonstrate commitment to nuclear safety with their attributes and decision-makings
- Place highest priorities on nuclear safety, allow all individuals to express their questions or concerns, and promptly and seamlessly engage in improvement initiatives as an organization
- Have each member constantly keep nuclear safety in mind, and think and act to achieve higher qualities

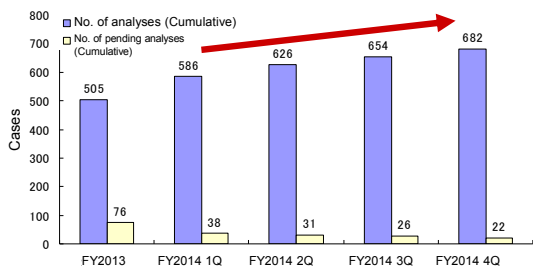
### <Safety Awareness KPI performance (FY2014 4Q)>

<ul style="list-style-type: none"> <li>Self-evaluation on nuclear safety</li> </ul>	<p>94.3 points (Management / nuclear power leadership)</p> <p>67.3 points (The Nuclear Power Division overall)</p>	<p>Since the number of times that meetings to reflect on issues were held fell far short of objectives, efforts will be made to have such meetings held on a departmental level.</p>
<ul style="list-style-type: none"> <li>Communication of safety-related messages by nuclear power leadership and employees' understandings</li> </ul>	<p>100 points (Indicator on communicating messages)</p>	<p>This indicates that the message is being conveyed and received, but the intentions and instructions of Nuclear Power Division executives have not permeated down to the front lines in the field.</p>

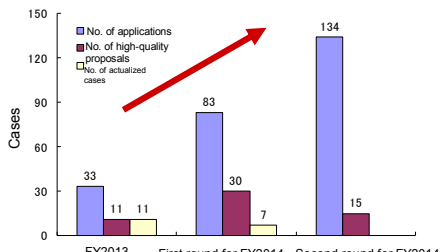
## Improving Technological Capability

### Measure3 : Strengthening the ability to propose defense in depth

- With the assumption that events at other power stations can equally break out at TEPCO's power stations, the company's Nuclear Power Division is making combined efforts on a daily basis to collect international OE-related information, and to promptly interpret them and draw up measures.
- Acting on the information obtained, the company stages a competition in which all employees, regardless of their positions, can point out facility and operational risks and propose improvements in an effort to promptly actualize them.



✓ Status of collected and analyzed OE information



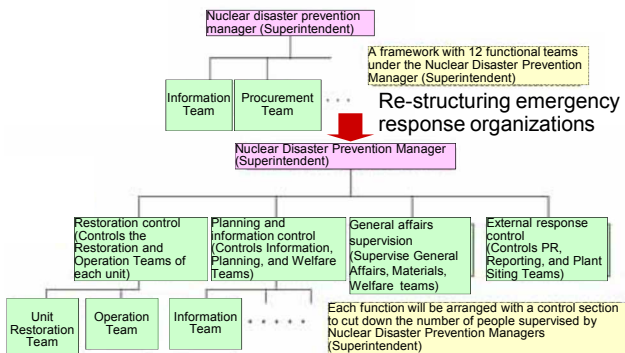
✓ No. of applications to competitions, high-quality proposals, and actualized cases



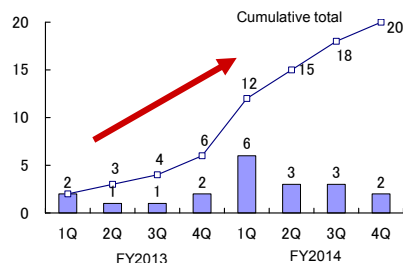
✓ (Example of actualized proposals) Deploying equipment to control valves under emergencies

### Measure5 : Strengthening emergency response capabilities of the power station and Headquarters (organizational levels)

- Reflecting on the accident, TEPCO introduced ICS, the most advanced emergency response framework, to power stations and the Headquarters upon obtaining guidance from external experts.
- TEPCO has made emergency preparedness a pillar of its operations and is striving on a daily basis to improve the ability to respond on all levels of the organization by refining the skills of workers to restore equipment and operate heavy machinery, and participating in joint training with the local government.



✓ Re-structuring emergency response organizations

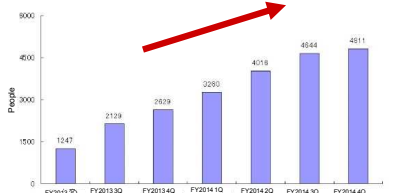


✓ The number of comprehensive trainings conducted at KK and photos from the training



### Measure6 : Strengthening emergency response capabilities (individual levels) and field personnel capabilities

- Reflecting on the accident, TEPCO is improving its skills to restore facilities and control heavy equipment in its endeavor to become a power station that can cope with circumstances where there is little hope for assistance on restoration. For instance, nearly all field members have acquired the necessary capabilities as per the allocation of roles under emergencies.



✓ Transition of the number of individuals attending self-response trainings at Kashiwazaki-Kariwa



✓ Debris removal trainings



✓ Trainings to connect power supply cars



✓ Trainings to connect temporary cables



✓ Trainings to restore cooling water pumps

## Issues and Future Activities

### Issues:

- TEPCO's ability to propose defense in depth, its emergency response capabilities, and its field personnel capabilities are increasing, but the company should compare this with other industries or nuclear operators in Japan and abroad, instead of being satisfied with this trend.

### Future Activities:

- By comparing with domestic and international good practices, TEPCO will achieve the world's highest-level technological capabilities.
- Starting from FY2015, TEPCO will initiate monitoring processes that leverages KPIs

## Goals

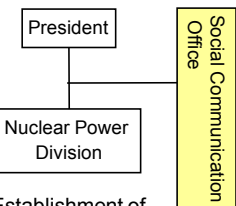
- TEPCO will constantly pursue and conduct the world's highest-level safety measures.
- TEPCO will always learn from internal and external failures, troubles, and issues, and actively work to incorporate the learnings.
- TEPCO will constantly scale up its emergency response capabilities, and be ready to address all accident types by internally preparing the technological capabilities that are needed.

## Improving the Dialogue- Promoting Capability

## Issues and Future Activities

### Measure4 : Enhancing Risk Communication Activities

- In April 2013, TEPCO set up the Social Communication Office under direct control of the President, and invited an external personnel to head the Office (January 2014). The Office looks 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. These members are specialists to enable straightforward interactions with the public from a position close to management or nuclear power leadership (37 members in total). With the understanding that no safety is infallible, the risk communicators provide explanations and communicate with the public.



✓ RC training sessions



✓ Press conference hosted by RCs

✓ Establishment of the Social Communication Office



Head: Ms.Chisa Enomoto

#### <Dialogue-Promoting Capability KPI and Assessment (FY2014 4Q)>

■ Dialogue-Promoting Capability (Internal)	<b>75.0 points</b> (Entire Nuclear Power Division) <b>77.3 points</b> (Nuclear Power Division executives)	Since these scores are quite different from the self-assessment scores for "emphasizing expectations" and "free flow of information" by Nuclear Power Division executives and the entire Nuclear Power Division, the details will be analyzed and improvements made.
■ Dialogue-Promoting Capability (External)	<b>+1.3 points</b> (Quality and quantity of information disseminated) <b>+1.2 points</b> (Significance and stance of public information)	These scores concern the dissemination of information that is easy-to-understand, but in light of failures to disclose information further improvements shall be made and the efficacy of those improvements verified.

### Issues:

- In light of the problem of nondisclosure of information about contaminated drainage water reaching the sea, the gap in risk perception remains, and TEPCO has yet to regain public trust.

### Future Activities:

- TEPCO will change its rules and operations to disclose all data.
- TEPCO will regularly scale up its transparency and reliability by undergoing external observations and evaluations on new data disclosure rules and operational performances.

### Goals

- TEPCO will take note and respond to calls from the society, and develop a relationship built on trust
- TEPCO will continue to communicate with the public on nuclear-specific risks, thereby offering the public a thorough understanding on risks

## <Reference> Major proposals and evaluations previously issued by the Nuclear Reform Monitoring Committee

<p>Safety Awareness</p>	<ul style="list-style-type: none"> <li>The management should have an adequate awareness on the necessity for reforms and take the lead while having all employees understand and thoroughly follow these needs. (The Third Nuclear Reform Monitoring Committee)</li> <li>TEPCO should have the entire organization, ranging from management to managers at the field frontline, fully understand safety culture and should constantly strive to attain a further level of excellence. (The Seventh Nuclear Reform Monitoring Committee)</li> <li>In light of NSOO's proposals, the Board of Directors is issuing improvement orders to operating divisions and checking its progress on a regular basis, thereby demonstrating that nuclear safety governance is steadily being stepped up (The Seventh Nuclear Reform Monitoring Committee)</li> </ul>
<p>Technological Capability</p>	<ul style="list-style-type: none"> <li>TEPCO should engage in interactive communications on a global platform by setting international good practices as a benchmark or sharing activities or improvements based on lessons learned from the Fukushima accident. Japan should learn from the world, and vice versa. (Comment on the Nuclear Safety Reform Plan Progress Report (FY2014 3Q) by Chairman Dr. Klein)</li> <li>Kashiwazaki-Kariwa is steadily engaging in safety measures in response to the lessons learned from the Fukushima Daiichi NPS accident (The Seventh Nuclear Reform Monitoring Committee)</li> </ul>
<p>Dialogue-Promoting Capability</p>	<ul style="list-style-type: none"> <li>TEPCO should place importance on transparency; it should work to eradicate doubts suspecting that the company is concealing information. Under event breakouts, engineers tend to not disclose information until confirming all the facts, but TEPCO should immediately announce what is and is not clear at the concerned moment, as well as what responses are being undertaken. (Comment on the Nuclear Safety Reform Plan Progress Report (FY2013 2Q) by Chairman Dr. Klein)</li> <li>With regard to risk communication during accidents or troubles, TEPCO should achieve a fundamental makeover of internal information distribution and sharing, and fully activate both risk communicators and the Social Communication Office in an effort to promptly and accurately disclose information. (The Fourth Nuclear Reform Monitoring Committee)</li> </ul>