

Japanese Earthquake and Tsunami – Implications for the UK Nuclear Industry

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Summary and Recommendation:

On 14th March 2011 the Secretary of State (SoS) for Energy and Climate Change requested HM Chief Inspector of Nuclear Installations, Dr Mike Weightman, to examine the circumstances of the Fukushima accident in Japan on 11th March. A report highlighting initial findings was published in May which formed the subject of a report to the Strategic & Nuclear Energy Board in September of last year. The final report from Dr Weightman was published in October and was the subject of a further report to Members on 24th Nov.

The purpose of this report is to appraise Members of a recent update from Government in the form of a letter from Secretary of State at DECC, Ed Davey to Dr Weightman, published on 25th June of this year and attached as an appendix to this report.

In addition on 5th July the Japanese Government published its report into the incident which is summarised below.

Members are asked to note the report.

1. BACKGROUND

This report summarises two recent publications. The first is a further government response to the Weightman Report and the second is a report into the Fukushima incident published on 4th July by the Japanese Government.

1.1 The Weightman Report

The letter from Secretary of State Ed Davey to Dr. Mike Weightman of 25th June provides an update of Government's views on Dr Weightman's final report published last October on the implications of the Fukushima accident for the UK nuclear industry. It is worth re-iterating that the final report found that:

- There is no reason to curtail the operation of UK operating sites, although operators should continue to follow the founding principle of continuous improvement.
- There are no fundamental weaknesses in the UK nuclear licensing regime or the safety assessment principles that underpin it ...

- The final report also confirms Dr Weightman’s advice ... that he saw no reason to revise the strategic advice given by the regulators on which the Nuclear National Policy Statement was based, or any need to change present siting strategies for new nuclear power stations in the UK.
- The UK practice of periodic safety reviews of licensed sites provides a robust means of ensuring continuous improvement ...
- The events at Fukushima reinforce the need to continue to pursue decommissioning of former nuclear sites with utmost vigour and determination.
- The regulator is satisfied with the responses and plans initiated by the Government and nuclear industry in response to the interim report.”

The summary of the final report confirms that “the direct causes of the nuclear accident at Fukushima, a magnitude 9 earthquake and the associated 14m high tsunami, are far beyond the most extreme natural events that the UK could be expected to experience” (page v).

On 25th June Secretary of State wrote to Dr. Mike Weightman, HM Chief Inspector of Nuclear Installations, with an update on the Governments position regarding the final report prepared by Dr Weightman in October last year. A full version of the letter and attachments is attached to this report.

1.2 Issues of relevance to Copeland

The original report contained a range of recommendations affecting the full scope of stakeholders involved in the UK Nuclear industry including Government, regulators and operators. The letter contains an update of Governments response in relation to each of the recommendations. Of specific relevance it is worth noting;

- Recommendation IR-2 concerns learning lessons from the Japanese response to the emergency. Government has instigated a review of the Japanese response and will use this to compare with the Government’s own civil contingency planning. The review will be completed and findings published once the Japanese work has been completed.
- Recommendation IR-3 concerns the Nuclear Emergency Planning Liaison Group (NEPLG) reviewing the UK’s national nuclear emergency arrangements in the light of the Japanese event. This review has so far looked at a re-evaluation of radiation monitoring and testing of off-site emergency plans along with the provision of technical advice and information in the event of such an incident. The Office for Nuclear Regulation (ONR) are being asked to prepare and enforce a stronger testing regime which includes extendibility arrangements and these are being discussed with local authorities. There is also further work underway to review capacity and capability of the Emergency Services to deal with such a response and exposure levels. In addition DECC has developed and agreed, with key delivery partners across Whitehall, industry and the regulator, a new National Strategic Framework to strengthen governance arrangements and provide clear lines of tasking, communication and decision making between operational delivery and

Ministerial involvement. In relation to this DECC is also working with international partners to benchmark emergency arrangements.

- Recommendation FR-5 concerns the adequacy of the existing system of planning controls around nuclear licensed sites. The ONR has included the recommendation on planning controls around nuclear sites in their consultation response to the Government's proposed National Planning Policy Framework for England (NPPF) which has now been published.

2. OFFICIAL JAPANESE GOVERNMENT REPORT OF THE FUKUSHIMA NUCLEAR INCIDENT

2.1 On 5th July the Japanese Government published its own report into the Fukushima incident. The parliamentary report is based on more than 900 hours of hearings and interviews with 1,167 people and suggests that reactor No. 1, in particular, may have suffered earthquake damage — including the possibility that pipes burst from the shaking, leading to a loss of cooling even before the tsunami hit the plant about 30 minutes after the initial earthquake. It emphasized that a full assessment would require better access to the inner workings of the reactors, which could take years.

The full report contains an 88 page executive summary which is available at <http://rfflibrary.wordpress.com/2012/07/05/the-official-report-of-the-fukushima-nuclear-accident-investigation-commission-executive-summary/>

An extract from the Executive Summary, listing the conclusions of the commission and the recommendations is attached as Appendix 2 to this report.

The full report outlines 'a string of errors and wilful negligence that left the Fukushima plant unprepared for the events of 11 March 2011, and examines "serious deficiencies" in the response to the accident' It concludes with a number of key findings;

2.2 KEY FINDINGS

- **Collusion and lack of governance** by government, regulators and Tepco (the operator)
- **Insufficient knowledge and training** within Tepco
- **Lack of preparation** on part of government, regulators, Tepco and prime minister's office to allow adequate response to accident of this scope, **including mounting effective evacuation**
- **Laws and regulations based on stopgap measures** in response to previous accidents - need comprehensive review

In his concluding statement chairman of the Commission Kiyoshi Kurokawa commented that the disaster was natural but the panic and confusion were 'manmade' and was a disaster 'made in Japan', making reference to 'ingrained conventions in Japanese culture' around 'reflexive obedience and reluctance to question authority'. The report further concludes that 'the root causes were the

organizational and regulatory systems... rather than issues relating to the competency of any specific individual. [All parties] failed to correctly develop the most basic safety requirements - such as assessing the probability of damage, preparing for containing collateral damage from such a disaster, and developing evacuation plans for the public in the case of a serious radiation release. And in terms of emergency response the Commission concluded that 'The government, the regulators, Tepco management, and the Kantei [prime minister's office] lacked the preparation and the mindset to efficiently operate an emergency response to an accident of this scope. None, therefore, were effective in preventing or limiting the consequential damage'. Mr Kurokawa continues 'There was great confusion over the evacuation, caused by prolonged shelter-in-place orders and voluntary evacuation orders. Some residents were evacuated to high dosage areas because radiation monitoring information was not provided'.

The report also concludes that the regulators and the operator Tepco did not fulfil their specific and that laws and regulations have not been seriously and comprehensively reviewed to reflect international standards.

The report concludes with a range of recommendations;

2.3 Recommendations

- **Permanent committee in National Diet** [parliament] to oversee the regulators, with regular investigations and hearings
- **Reform of the crisis management system**, making boundaries between responsibilities of local and national governments and the operators clear, and establishing clear chain of command in emergency situations
- Establishment of **system to deal with long-term public health effects**, including monitoring and decontaminating radiation-affected areas
- **Dramatic corporate reform of Tepco** and new relationships established among the electric power companies built on safety issues, mutual supervision and transparency
- **New regulatory body** established on independence, transparency, professionalism, and consolidation of functions
- **Reform of laws related to nuclear energy** to meet global standards of safety, public health and welfare
- Develop a **system of independent investigation commissions**

A response or reaction to the publication from UK Government has yet to be received but will be verbally reported if available at the meeting

3. List of Appendices

Appendix A – Letter from Ed Davey to Mike Weightman 25th June 2012

Appendix B – Extract from the Executive Summary of the Japanese Government report of the Fukushima incident

4. Consultees



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JAPANESE EARTHQUAKE AND TSUNAMI: IMPLICATIONS FOR THE UK NUCLEAR INDUSTRY

I would like to use this opportunity to thank you and your team for all your hard work in the production of the final report on the events at Fukushima and the implications for the UK nuclear industry.

As you know, Government originally responded to the findings and recommendations of the report in December 2011, ahead of your June 2012 deadline. In light of this I hereby have the pleasure of attaching an update to the Government's December 2011 response in time for your implementation report at the end of this year.

DECC continues to work closely with your team and with industry to deliver the recommendations in your report, including through our collaboration on the National Strategic Framework for Nuclear Emergency Planning and Response, which we launched at the end of last year.

Thank you again for your continued work on this important issue.

EDWARD DAVEY

Recommendation IR - 1: The government should approach the IAEA, in co-operation with others, to ensure that improved arrangements are in place for the dissemination of timely authoritative information relevant to a nuclear event anywhere in the world.

Recommendation FR – 9: The UK Government, nuclear industry and ONR should support international efforts to improve the process of review and implementation of IAEA and other relevant nuclear safety standards and initiatives in the light of the Fukushima-1 (Fukushima Dai-ichi) accident.

Action

The Government has continued to work with its partners in the G8, G20 and other international fora to ensure better compliance with international conventions and push forward work on enhancing nuclear safety standards established under the auspices of the IAEA.

The UK has participated in the IAEA activities that led to the development of the Director General's Action Plan and will continue to work with the IAEA to help ensure the delivery mechanism for the Action Plan is both robust and realistic - especially bearing in mind the significance of the work it proposes.

In meeting the actions proposed by the plan the UK have already committed, through the UK's statement at the IAEA Ministerial Conference, to participate in further IRRS peer review missions. The UK has also become a member of IAEA's global assistance mechanism in the event of a nuclear emergency, RANET (Response and Assistance Network).

We have also fully participated in the EU stress test initiative, fulfilling the requirement to undertake a comprehensive assessment of safety at the UK's nuclear power plants.

We are also committed to working with our international partners to consider how the dissemination of information under the Convention on Early Notification of a Nuclear Accident can be further improved in terms of both efficiency and substance.

Recommendation IR - 2: The Govt should consider carrying out a review of the Japanese response to the emergency to identify any lessons for UK public contingency planning for widespread emergencies, taking account of any social, cultural and organisational differences.

Action

The Government has carried out a review of the Japanese response to the widespread civil emergency that occurred following the Tohoku Earthquake and Tsunami of March 2011. We are now comparing our findings with our own civil contingency planning to identify whether there are lessons that can be learnt from the Japanese experience to improve our own planned response to (catastrophic) emergencies.

The review has considered:

- What happened in Japan: the earthquake and tsunami and their impact.
- The Japanese response to the range of diverse impacts that occurred across a large geographical area.
- The current phase of the review is focussing on:
 - Current UK risk identification, contingency planning and capacity building processes;
 - Key issues arising from the Japanese experience which have read across with UK contingency planning – to enable us to identify lessons that may be learnt to make our planning even more robust.

We have consulted with, and gained valuable evidence from, the Japanese Government and the FCO, as well as a range of publically available reports that have already been written about the emergency. In order to complete this review in a timely way, we will use the evidence currently available to inform our thinking, but the Japanese response to this crisis is still ongoing and further evidence continues to emerge: it is unlikely that final conclusions will be able to be drawn before the Japanese have been able to complete and evaluate their response in full, we will therefore aim to publish our findings once the Japanese work has been completed.

Recommendation IR - 3: The Nuclear Emergency Planning Liaison Group (NEPLG) should instigate a review of the UK's national nuclear emergency arrangements in light of the experience of dealing with the prolonged Japanese event.

Action

In May 2011, the Nuclear Emergency Planning Liaison Group (NEPLG) agreed, in response to Recommendation 3 of the Interim Weightman Report, to conduct a review of the UK's national nuclear emergency arrangements in light of the experience of dealing with the prolonged Japanese event.

As part of that review and in further work the NEPLG examined the decisions and actions that were taken in Japan to protect the public, and considered any lessons that the UK could learn from those actions. This included a re-evaluation of radiation monitoring capacity/ capability and recommended that Central Government clarify the requirements for delivering the data and information in the event of a prolonged incident in the UK and that these arrangements be tested annually. Exercises of off-site emergency plans are being reviewed so that they regularly include aspects such as extendibility, dealing with prolonged events and the deployment of Reassurance Monitoring Units. The NEPLG work also assessed central government response arrangements and in particular the provision of scientific and technical advice in the event of a nuclear emergency in the UK or overseas to ensure that COBR has one source of advice and recommended that the Overseas Nuclear Emergency response plan be tested fully through the Nuclear Energy Agency International Exercise programme.

The report also recommended that the Office for Nuclear Regulation (ONR) should enforce a stronger testing regime which includes extendibility arrangements and overseas nuclear accident response. A range of options for taking forward extendibility have been debated and discussed via the NEPLG Local Authority (LA) Sub Group. This has also been supplemented with a number of face to face visits with several LA's to further discuss the enhanced clarity required for extendibility. A draft paper detailing the preferred ONR option has been produced and is currently

being finalised. Exploration of the legislative vehicle for implementation of extendibility has been concluded with advice provided by the Treasury Solicitors (TSoL) and ONR. Finally the work recommended that NEPLG and Central Government continued to work on the capacity and capability of the Emergency Services including emergency exposures levels to ensure that the Fire, Ambulance and Police Services have a clear understanding of radiation exposure levels and the circumstances in which they can carry out their work, recommending that emergency services and operators should liaise formally to determine emergency exposure. The recommendations referring to Emergency Services, in particular exposure levels for emergency responders have been handled by NEPLG. Further information on exposure levels for the Ambulance service are at: <http://www.parliament.uk/deposits/depositedpapers/2010/DEP2010-2022.pdf> For the Fire and Rescue service, information is contained in the Generic Risk Assessment found at: <http://www.communities.gov.uk/publications/fire/GRA5.5> In addition there is a new fire service 'HazMat' Manual that has a radiation chapter and this will be published at the end of June 2012. Guidance on Police exposure levels is currently in production and is due to be published shortly.

The opportunities and recommendations identified by NEPLG form part of a wider programme of work being taken forward by the Department of Energy and Climate Change (DECC).

In looking to answer the recommendations from the NEPLG work and other further work DECC has developed and agreed, with key delivery partners across Whitehall, industry and the regulator, a new National Strategic Framework. This Framework significantly strengthens governance arrangements and in particular provides clear lines of tasking, communication and decision making between operational delivery and Ministerial involvement.

As mentioned in the report, and driven by the new strategic framework, initial comprehensive assessments have been completed UK's capacity to plan for and respond to a nuclear emergencies – both at 'reasonably foreseeable' and

'reasonable worst case' scenario level and DECC/ NEPLG are currently developing options for closing any gaps where they are found to exist.

In addition, as part of addressing IR-3, DECC, under the new strategic framework, is also taking forward a number of international projects in order to better understand the risks the UK faces and strengthen our ability to respond. This work includes for example, a new joint UK-France framework on emergency planning and the international benchmarking of UK emergency arrangements. DECC, is also working with the NEPLG on the guidance for responding to malicious incidents and events overseas.

Recommendation FR-6: The nuclear industry with others should review available techniques for estimating radioactive source terms and undertake research to test the practicability of providing real-time information on the basic characteristics of radioactive releases to the environment to the responsible off-site authorities, taking account of the range of conditions that may exist on and off the site.

Action

The Office for Nuclear Regulation (ONR), the Met Office (MO), the Health Protection Agency (HPA) and the RIMNET team at the Department of Energy and Climate Change (DECC) continue to work together to further develop the capability to be able to respond quickly to any incident at a nuclear site anywhere in the world. The objective of this capability is for the UK to be able to draw upon the collective resources and expertise of the operators, regulators and others, as necessary.

The work has been building upon existing arrangements in place for incidents in the UK whilst developing an appropriate basis and supporting procedures for overseas responses. ONR and UK operators will advise on the plant status and potential source terms and progress has been made on the development of an initial set of pre-defined source terms in conjunction with the nuclear industry. MO have further developed their tools to model dispersion of radioactive materials in the atmosphere based on guidance provided by HPA on the most appropriate pathways and other dose factors required to estimate doses to individuals.

Together these provide an auditable means of rapidly assessing the potential impact of an incident on the UK or its citizens. Any results will be displayed using DECC's RIMNET system.

This work is being coordinated by DECC with input from other Government Department and Agencies, including GO Science. The aim is to have an initial tool available for use by Summer 2012.

Recommendation FR-7: The Government should review the adequacy of arrangements for environmental dose measurements and for predicting dispersion and public doses and environmental impacts, and to ensure that adequate up to date information is available to support decisions on emergency countermeasures.

Action

In the event of a radioactive release from a nuclear site, the operators are responsible for carrying out monitoring in the immediate vicinity with the Health Protection Agency (HPA) coordinating monitoring further afield; this information together with emergency plans is used for the immediate emergency response. These arrangements are kept under review by the National Emergency Planning Liaison Group. There are a number of other initiatives in this area, including a review of the Radioactive Incident Monitoring Network (RIMNET), which is the UK Government's emergency management system for overseas nuclear accidents, which comes under the Department for Energy and Climate Change. It supports, in addition to its original function, the national level response to civil and military incidents that may occur within UK borders.

In addition, HPA, the Environment Agency (EA) the Scottish Environment Protection Agency (SEPA) and the Northern Ireland Environment Agency (NIEA) all carry out or coordinate routine environmental monitoring for radionuclides. In the event of a radiological emergency, this routine monitoring would be enhanced if necessary and used to provide information that would support later decisions on emergency countermeasures. The Met Office has the capability for providing atmospheric dispersion information in real time following any incident in the UK and worldwide. Met Office is part of a collaboration, coordinated by DECC, with contributions from the Office for Nuclear Regulation (ONR) and HPA to develop a tool for estimating the spatial distribution of radiation doses in real time following a radiation release in the UK or elsewhere. The different initiatives should ensure that information is available to support decisions on emergency countermeasures.

Recommendation FR-5: The relevant Government departments in England, Wales and Scotland should examine the adequacy of the existing system of planning controls for commercial and residential developments off the nuclear licensed site.

Action

The ONR has included Dr Weightman's recommendation on planning controls around nuclear sites in their consultation response to the Government's proposed National Planning Policy Framework for England (NPPF). The NPPF has now been published and is available at:

<http://www.communities.gov.uk/publications/planningandbuilding/nppf>

Planning is a devolved matter and, as such, the Government's NPPF process only applies to England, however we will continue to work closely with our colleagues in the Devolved Administration on this issue.

Recommendation FR-8: The Government should consider ensuring that the legislation for the new statutory body requires ONR to be open and transparent about its decision-making, so that it may clearly demonstrate to stakeholders its effective independence from bodies or organisations concerned with the promotion or utilisation of nuclear energy.

Action

The work that is currently taking place on the creation of a statutory ONR has at its heart the transparency of the regulator and its relationship with Government (including bodies concerned with the promotion or utilisation of nuclear energy). The intention is for the statutory ONR's five year Strategy, annual plan, annual report and accounts to all be shown to Parliament as well as widely published by the statutory ONR itself. In addition, the Secretary of State will report to Parliament on any directions that he gives to the statutory ONR as well as the use of his powers such as making appointments to the statutory ONR Board. In addition, the statutory ONR will report every five years to Parliament on the functioning of the nuclear regulatory regime.

All of these measures, the creation of the statutory ONR's Board and giving the statutory ONR powers and duties over nuclear regulation in its own right (not currently the case), will lead to greater transparency. This will help to clearly show the statutory ONR's effective independence from anybody concerned with the promotion or utilisation of nuclear energy.

The inclusion of an Energy Bill in the second session of Parliament was confirmed by the Queen in her speech at the state opening of Parliament on 9 May 2012. The Energy Bill will contain provisions to create the Office for Nuclear Regulation as an independent statutory corporation. The Bill will be introduced when Parliamentary time allows.

Appendix B

Extract from the Executive Summary of the Japanese Government report of the Fukushima nuclear incident

Conclusions

After a six-month investigation, the Commission has concluded the following: In order to prevent future disasters, fundamental reforms must take place. These reforms must cover both the structure of the electric power industry and the structure of the related government and regulatory agencies as well as the operation processes. They must cover both normal and emergency situations.

A “manmade” disaster

The TEPCO Fukushima Nuclear Power Plant accident was the result of collusion between the government, the regulators and TEPCO, and the lack of governance by said parties. They effectively betrayed the nation’s right to be safe from nuclear accidents. Therefore, we conclude that the accident was clearly “manmade.” We believe that the root causes were the organizational and regulatory systems that supported faulty rationales for decisions and actions, rather than issues relating to the competency of any specific individual. (see Recommendation 1)

The direct causes of the accident were all foreseeable prior to March 11, 2011. But the Fukushima Daiichi Nuclear Power Plant was incapable of withstanding the earthquake and tsunami that hit on that day. The operator (TEPCO), the regulatory bodies (NISA and NSC) and the government body promoting the nuclear power industry (METI), all failed to correctly develop the most basic safety requirements—such as assessing the probability of damage, preparing for containing collateral damage from such a disaster, and developing evacuation plans for the public in the case of a serious radiation release. TEPCO and the Nuclear and Industrial Safety Agency (NISA) were aware of the need for structural reinforcement in order to conform to new guidelines, but rather than demanding their implementation, NISA stated that action should be taken autonomously by the operator. The Commission has discovered that no part of the required reinforcements had been implemented on Units 1 through 3 by the time of the accident. This was the result of tacit consent by NISA for a significant delay by the operators in completing the reinforcement. In addition, although NISA and the operators were aware of the risk of core damage from tsunami, no regulations were created, nor did TEPCO take any protective steps against such an occurrence. Since 2006, the regulators and TEPCO were aware of the risk that a total outage of electricity at the Fukushima Daiichi plant might occur if a tsunami were to reach the level of the site. They were also aware of the risk of reactor core damage from the loss of seawater pumps in the case of a tsunami larger than assumed in the Japan Society of Civil Engineers estimation. NISA knew that TEPCO had not prepared any measures to lessen or eliminate the risk, but failed to provide specific instructions to remedy the situation. We found evidence that the regulatory agencies would explicitly ask about the operators’ intentions whenever a new regulation was to be implemented. For example, NISA informed the operators that they did not need to consider a possible station blackout

(SBO) because the probability was small and other measures were in place. It then asked the operators to write a report that would give the appropriate rationale for why this consideration was unnecessary. In order to get evidence of this collusion, the Commission was forced to exercise our legislative right to demand such information from NISA, after NISA failed to respond to several requests. The regulators also had a negative attitude toward the importation of new advances in knowledge and technology from overseas. If NISA had passed on to TEPCO measures that were included in the B.5.b subsection of the U.S. security order that followed the 9/11 terrorist action, and if TEPCO had put the measures in place, the accident may have been preventable. There were many opportunities for taking preventive measures prior to March 11. The accident occurred because TEPCO did not take these measures, and NISA and the Nuclear Safety Commission (NSC) went along. They either intentionally postponed putting safety measures in place, or made decisions based on their organization's self interest, and not in the interest of public safety.

From TEPCO's perspective, new regulations would have interfered with plant operations and weakened their stance in potential lawsuits. That was enough motivation for TEPCO to aggressively oppose new safety regulations and draw out negotiations with regulators via the Federation of Electric Power Companies (FEPC). The regulators should have taken a strong position on behalf of the public, but failed to do so. As they had firmly committed themselves to the idea that nuclear power plants were safe, they were reluctant to actively create new regulations. Further exacerbating the problem was the fact that NISA was created as part of the Ministry of Economy, Trade & Industry (METI), an organization that has been actively promoting nuclear power.

Earthquake damage

We conclude that TEPCO was too quick to cite the tsunami as the cause of the nuclear accident and deny that the earthquake caused any damage. We believe there is a possibility that the earthquake damaged equipment necessary for ensuring safety, and that there is also a possibility that a small-scale LOCA occurred in Unit 1. We hope these points will be examined further by a third party. (see Recommendation 7)

Although the two natural disasters—the earthquake and subsequent tsunami—were the direct causes of the accident, there are various points in the unfolding of the event that remain unresolved. The main reason for this is that almost all the equipment directly related to the accident is inside the reactor containers, which are inaccessible and will remain so for many years. A complete examination and full analysis are impossible at this time.

TEPCO was quick, however, to assign the accident cause to the tsunami, and state that the earthquake was not responsible for damage to equipment necessary for safety (although it did add, “to the extent that has been confirmed,” a phrase that also appears in TEPCO reports to the government and to the IAEA). However, it is impossible to limit the direct cause of the accident to the tsunami without substantive evidence. The Commission believes that this is an attempt to avoid responsibility by putting all the blame on the unexpected (the tsunami), as they wrote in their midterm report, and not on the more foreseeable earthquake. Through our investigation, we have verified that the people involved were aware of the risk from both earthquakes and tsunamis. Further, the damage to Unit 1 was caused not only by the tsunami but also by the earthquake, a conclusion made

after considering the facts that: 1) the largest tremor hit after the automatic shutdown (SCRAM); 2) JNES confirmed the possibility of a small-scale LOCA (loss of coolant accident); 3) the Unit 1 operators were concerned about leakage of coolant from the valve, and 4) the safety relief valve (SR) was not operating.

Additionally, there were two causes for the loss of external power, both earthquake-related: there was no diversity or independence in the earthquake-resistant external power systems, and the Shin-Fukushima transformer station was not earthquake resistant. (See Section 2 of the Summary of Findings)

Evaluation of operational problems

The Commission concludes that there were organizational problems within TEPCO. Had there been a higher level of knowledge, training, and equipment inspection related to severe accidents, and had there been specific instructions given to the on-site workers concerning the state of emergency within the necessary time frame, a more effective accident response would have been possible. (see Recommendation 4)

There were many problems with on-site operations during the accident. Events make it clear that if there are no response measures for a severe accident in place, the steps that can be taken on-site in the event of a station blackout are very limited. Recovery work, such as confirming the operation of the isolation condenser (IC) in Unit 1, should have been conducted swiftly because of the loss of DC power, but was not. TEPCO did not plan measures for the IC operation, and had no manual or training regimens, so these are clearly organizational problems. Regarding the vent line composition, conducting line configuration work in a situation with no power and soaring radiation levels must have been extremely difficult and time consuming. On top of this, sections in the diagrams of the severe accident instruction manual were missing. Workers not only had to work using this flawed manual, but they were pressed for time, and working in the dark with flashlights as their only light source. The Kantei's (Prime Minister's Office) distrust of TEPCO management was exacerbated by the slow response, but the actual work being done was extremely difficult. Many layers of security were breached simultaneously, and the power to four reactors was lost at the same time. Had there not been some coincidental events—such as the RCIC in Unit 2 operating for so many hours, the blow-out panel falling out and releasing pressure, and the speed with which subcontractors cleaned up wreckage—Units 2 and 3 would have been in an even more precarious situation. We have concluded that—given the deficiencies in training and preparation—once the total station blackout occurred, including the loss of a direct power source, it was impossible to change the course of events.

Emergency response issues

The Commission concludes that the situation continued to deteriorate because the crisis management system of the Kantei, the regulators and other responsible agencies did not function correctly. The boundaries defining the roles and responsibilities of the parties involved were problematic, due to their ambiguity. (see Recommendation 2)

The government, the regulators, TEPCO management, and the Kantei lacked the preparation and the mindset to efficiently operate an emergency response to an accident of this scope. None, therefore, were effective in preventing or limiting the consequential damage.

NISA was expected to play the lead role as designated in the Act on Special Measures Concerning Nuclear Emergency Preparedness, which was enacted after a criticality accident at the JCO uranium conversion facility at Tokaimura, Ibaraki Prefecture in 1999. However, NISA was unprepared for a disaster of this scale, and failed in its function.

In the critical period just after the accident, the Kantei did not promptly declare a state of emergency. The regional nuclear emergency response team was meant to be the contact between the Kantei and the operator, responsible for keeping the Kantei informed about the situation on the ground. Instead, the Kantei contacted TEPCO headquarters and the Fukushima site directly, and disrupted the planned chain of command. A TEPCO-Kantei response team was created in TEPCO headquarters on March 15, but this body had no legal authority. The Kantei, the regulators and TEPCO all understood the need to vent Unit 1. TEPCO had been reporting to NISA, as was the standard protocol, that it was in the process of venting. But there is no confirmation that the venting decision was conveyed to senior members of METI, or to the Kantei. This failure of NISA's function and the scarcity of information at TEPCO headquarters resulted in the Kantei losing faith in TEPCO.

The Prime Minister made his way to the site to direct the workers who were dealing with the damaged core. This unprecedented direct intervention by the Kantei diverted the attention and time of the on-site operational staff and confused the line of command. While TEPCO headquarters was supposed to provide support to the plant, in reality it became subordinate to the Kantei, and ended up simply relaying the Kantei's intentions. This was a result of TEPCO's mindset, which included a reluctance to take responsibility, epitomized by President Shimizu's inability to clearly report to the Kantei the intentions of the operators at the plant. At the same time, it is hard to conclude that it was the Prime Minister who discouraged the idea of a full pullout by TEPCO, as has been reported elsewhere, for a number of reasons:

- 1) there is no evidence that the TEPCO management at the plant had even thought of a complete withdrawal;
- 2) There is no trace of a decision on a complete withdrawal being made at TEPCO headquarters;
- 3) The evacuation planned before Mr. Shimizu's visit to the Kantei included keeping emergency response members at the plant (though evacuation criteria were discussed);
- 4) The director-general of NISA reported that when Shimizu called him, he was not asked for advice on a full withdrawal; and
- 5) The off-site centre, which was connected through a video conference system, claimed there was no discussion of a complete withdrawal. Crisis management related to public safety should be assured without having to rely on the capability and judgement of the prime minister of any given time.

Evacuation issues

The Commission concludes that the residents' confusion over the evacuation stemmed from the regulators' negligence and failure over the years to implement adequate measures against a nuclear disaster, as well as a lack of action by previous governments and regulators focused on crisis management. The crisis management system that existed for the Kantei and the regulators should protect the health and safety of the public, but it failed in this function. (see Recommendation 2)

The central government was not only slow in informing municipal governments about the nuclear power plant accident, but also failed to convey the severity of the accident. Similarly, the speed of information in the evacuation areas varied significantly depending on the distance from the plant. Specifically, only 20 percent of the residents of the town hosting the plant knew about the accident when evacuation from the 3km zone was ordered at 21:23 on the evening of March 11. Most residents within 10km of the plant learned about the accident when the evacuation order was issued at 5:44 on March 12, more than 12 hours after the Article 15 notification—but received no further explanation of the accident or evacuation directions. Many residents had to flee with only the barest necessities and were forced to move multiple times or to areas with high radiation levels. There was great confusion over the evacuation, caused by prolonged shelter-in-place orders and voluntary evacuation orders. Some residents were evacuated to high dosage areas because radiation monitoring information was not provided. Some people evacuated to areas with high levels of radiation and were then neglected, receiving no further evacuation orders until April. The Commission has verified that there was a lag in upgrading nuclear emergency preparedness and complex disaster countermeasures, and attributes this to regulators' negative attitudes toward revising and improving existing emergency plans.

Continuing public health and welfare issues

The Commission recognizes that the residents in the affected area are still struggling from the effects of the accident. They continue to face grave concerns, including the health effects of radiation exposure, displacement, the dissolution of families, disruption of their lives and lifestyles and the contamination of vast areas of the environment. There is no foreseeable end to the decontamination and restoration activities that are essential for rebuilding communities. The Commission concludes that the government and the regulators are not fully committed to protecting public health and safety; that they have not acted to protect the health of the residents and to restore their welfare. (see Recommendation 3)

Approximately 150,000 people were evacuated in response to the accident. An estimated 167 workers were exposed to more than 100 millisieverts of radiation while dealing with the accident. It is estimated that as much as 1,800 square kilometers of land in Fukushima Prefecture has now been contaminated by a cumulative radiation dose of 5 millisieverts or higher per year. Insufficient evacuation planning led to many residents receiving unnecessary radiation exposure. Others were forced to move multiple times, resulting in increased stress and health risks—including deaths among seriously ill patients. The government must move to analyze the state of the residents' lives in the affected areas and systematically map out measures to improve their quality of life. These measures

should include the realignment of the evacuation zones, the restoration of the foundations of everyday life, decontamination issues, and realigning the medical and welfare systems to meet the public's needs. It has yet to do so. The more than 10,000 people who responded to our surveys, and the comments the Commission Members heard at town hall meetings offer harsh judgment of the government's present stance. While exposure levels are set as a threshold against acute radiation disorder, there is no widely accepted threshold for long-term radiation damage caused by low doses. The international consensus, however, is that the risk does increase in proportion to the dose. The impact of radiation on health may vary from one person to another depending on age, sensitivity to radiation and other factors, some unknown.

After the accident, the government unilaterally announced a benchmark on dosage without giving the specific information that residents needed, including answers to questions like:

What is a tolerable level of exposure in light of long-term health effects?

How do health implications differ for individuals?

How can people protect themselves from radioactive substances?

The government has not seriously undertaken programs to help people understand the situation. The Nuclear Accident Independent Investigation Commission acted well enough to make their own behavioral judgments. They failed to explain, for example, the risks of radiation exposure to different segments of the population, such as infants and youths, expecting mothers, or people particularly susceptible to the effects of radiation.

Reforming the regulators

The Commission has concluded that the safety of nuclear energy in Japan and the public cannot be assured unless the regulators go through an essential transformation process. The entire organization needs to be transformed, not as a formality but in a substantial way. Japan's regulators need to shed the insular attitude of ignoring international safety standards and transform themselves into a globally trusted entity. (see Recommendation 5)

The regulators did not monitor or supervise nuclear safety. The lack of expertise resulted in "regulatory capture," and the postponement of the implementation of relevant regulations. They avoided their direct responsibilities by letting operators apply regulations on a voluntary basis. Their independence from the political arena, the ministries promoting nuclear energy, and the operators was a mockery. They were incapable, and lacked the expertise and the commitment to assure the safety of nuclear power. Moreover, the organization lacked transparency. Without the investigation by this Commission, operating independently of the government, many of the facts revealing the collusion between the regulators and other players might never have been revealed.

Reforming the operator

TEPCO did not fulfil its responsibilities as a private corporation, instead obeying and relying upon the government bureaucracy of METI, the government agency driving nuclear policy. At the same time, through the auspices of the FEPC, it manipulated the cozy relationship with the regulators to take the teeth out of regulations. (see Recommendation 4)

The risk management practices of TEPCO illustrate this. If the risk factors of tsunami are raised, for example, TEPCO would only look at the risk to their own operations, and whether it would result in a suspension of existing reactors or weaken their stance in potential lawsuits. They ignored the potential risk to the public health and welfare. (See Section 5) Problems with TEPCO's management style, based on the government taking final responsibility became explicit during the accident. It prioritized the Kantei's intent over that of the technical engineers at the site. TEPCO's behavior was consistently unclear, and the misunderstanding over the "complete withdrawal" from the plant is a good example of the confusion that arose from their behavior. (See Section 3) After the accident, TEPCO continued to avoid transparency in disclosing information. It limited disclosure to confirmed facts, and failed to disclose information that it felt was uncertain or inconvenient. Some examples of continuing disclosure issues include the delay in releasing electricity demand projections used as the basis for rolling blackouts, and the lack in up-to-date information on the core conditions at the plant.

Reforming laws and regulations

The Commission concludes that it is necessary to realign existing laws and regulations concerning nuclear energy. Mechanisms must be established to ensure that the latest technological findings from international sources are reflected in all existing laws and regulations. (see Recommendation 6)

Laws and regulations related to nuclear energy have only been revised as stopgap measures, based on actual accidents. They have not been seriously and comprehensively reviewed in line with the accident response and safeguarding measures of an international standard. As a result, predictable risks have not been addressed. The existing regulations primarily are biased toward the promotion of a nuclear energy policy, and not to public safety, health and welfare. The unambiguous responsibility that operators should bear for a nuclear disaster was not specified. There was also no clear guidance about the responsibilities of the related parties in the case of an emergency. The defense in depth concept used in other countries has still not been fully considered.

Cosmetic solutions

Replacing people or changing the names of institutions will not solve the problems. Unless these root causes are resolved, preventive measures against future similar accidents will never be complete. (see Recommendations 4, 5 and 6)

The Commission believes the root causes of this accident cannot be resolved and that the people's confidence cannot be recovered as long as this "manmade disaster" is seen as the result of error by a specific individual. The underlying issue is the social structure that results in "regulatory capture," and the organizational, institutional, and legal framework that allows individuals to justify their own actions, hide them when inconvenient, and leave no records in order to avoid responsibility. Across the board, the Commission found ignorance and arrogance unforgivable for anyone or any organization that deals with nuclear power. We found a disregard for global trends and a disregard for public safety. We found a habit of adherence to conditions based on conventional procedures and prior

practices, with a priority on avoiding risk to the organization. We found an organization-driven mind-set that prioritized benefits to the organization at the expense of the public.

Recommendations

Based on the above findings, the Commission makes the following seven recommendations for the future. We urge the National Diet of Japan to thoroughly debate and deliberate on these recommendations.

Recommendation 1:

Monitoring of the nuclear regulatory body by the National Diet

A permanent committee to deal with issues regarding nuclear power must be established in the National Diet in order to supervise the regulators to secure the safety of the public.

Its responsibilities should be:

- 1.** To conduct regular investigations and explanatory hearings of regulatory agencies, academics and stakeholders.
- 2.** To establish an advisory body, including independent experts with a global perspective, to keep the committee's knowledge updated in its dealings with regulators.
- 3.** To continue investigations on other relevant issues.
- 4.** To make regular reports on their activities and the implementation of their recommendations.

Recommendation 2:

Reform the crisis management system

A fundamental reexamination of the crisis management system must be made. The boundaries dividing the responsibilities of the national and local governments and the operators must be made clear.

This includes:

- 1.** A re-examination of the crisis management structure of the government. A structure must be established with a consolidated chain of command and the power to deal with emergency situations.
- 2.** National and local governments must bear responsibility for the response to off-site radiation release. They must act with public health and safety as the priority.
- 3.** The operator must assume responsibility for on-site accident response, including the halting of operations, and reactor cooling and containment.

Recommendation 3:

Government responsibility for public health and welfare

Regarding the responsibility to protect public health, the following must be implemented as soon as possible:

- 1.** A system must be established to deal with long-term public health effects, including stress-related illness. Medical diagnosis and treatment should be covered by state funding. Information should be disclosed with public health and safety as the priority, instead of government convenience. This information must be comprehensive, for

use by individual residents to make informed decisions.

2. Continued monitoring of hotspots and the spread of radioactive contamination must be undertaken to protect communities and the public. Measures to prevent any potential spread should also be implemented.

3. The government must establish a detailed and transparent program of decontamination and relocation, as well as provide information so that all residents will be knowledgeable about their compensation options.

Recommendation 4:

Monitoring the operators

TEPCO must undergo fundamental corporate changes, including strengthening its governance, working towards building an organizational culture which prioritizes safety, changing its stance on information disclosure, and establishing a system which prioritizes the site. In order to prevent the Federation of Electric Power Companies (FEPC) from being used as a route for negotiating with regulatory agencies, new relationships among the electric power companies must also be established—built on safety issues, mutual supervision and transparency.

1. The government must set rules and disclose information regarding its relationship with the operators.

2. Operators must construct a cross-monitoring system to maintain safety standards at the highest global levels.

3. TEPCO must undergo dramatic corporate reform, including governance and risk management and information disclosure—with safety as the sole priority.

4. All operators must accept an agency appointed by the National Diet as a monitoring authority of all aspects of their operations, including risk management, governance and safety standards, with rights to on-site investigations.

Recommendation 5:

Criteria for the new regulatory body

The new regulatory organization must adhere to the following conditions.

It must be:

1. Independent: The chain of command, responsible authority and work processes must be: (i) Independent from organizations promoted by the government

(ii) Independent from the operators

(iii) Independent from politics.

2. Transparent: (i) The decision-making process should exclude the involvement of electric power operator stakeholders.

(ii) Disclosure of the decision-making process to the National Diet is a must.

(iii) The committee must keep minutes of all other negotiations and meetings with promotional organizations, operators and other political organizations and disclose them to the public.

(iv) The National Diet shall make the final selection of the commissioners after receiving third-party advice.

3. Professional: (i) The personnel must meet global standards. Exchange programs with overseas regulatory bodies must be promoted, and interaction and exchange of human resources must be increased.
(ii) An advisory organization including knowledgeable personnel must be established.
(iii) The no-return rule should be applied without exception.
4. Consolidated: The functions of the organizations, especially emergency communications, decision-making and control should be consolidated.
5. Proactive: The organizations should keep up with the latest knowledge and technology, and undergo continuous reform activities under the supervision of the Diet.

Recommendation 6:

Reforming laws related to nuclear energy

Laws concerning nuclear issues must be thoroughly reformed.

1. Existing laws should be consolidated and rewritten in order to meet global standards of safety, public health and welfare.
2. The roles for operators and all government agencies involved in emergency response activities must be clearly defined.
3. Regular monitoring and updates must be implemented, in order to maintain the highest standards and the highest technological levels of the international nuclear community.
4. New rules must be created that oversee the backfit operations of old reactors, and set criteria to determine whether reactors should be decommissioned.

Recommendation 7:

Develop a system of independent investigation commissions

A system for appointing independent investigation committees, including experts largely from the private sector, must be developed to deal with unresolved issues, including, but not limited to, the decommissioning process of reactors, dealing with spent fuel issues, limiting accident effects and decontamination