

Leadership and Safety Culture: Personal Reflections on Lessons Learned

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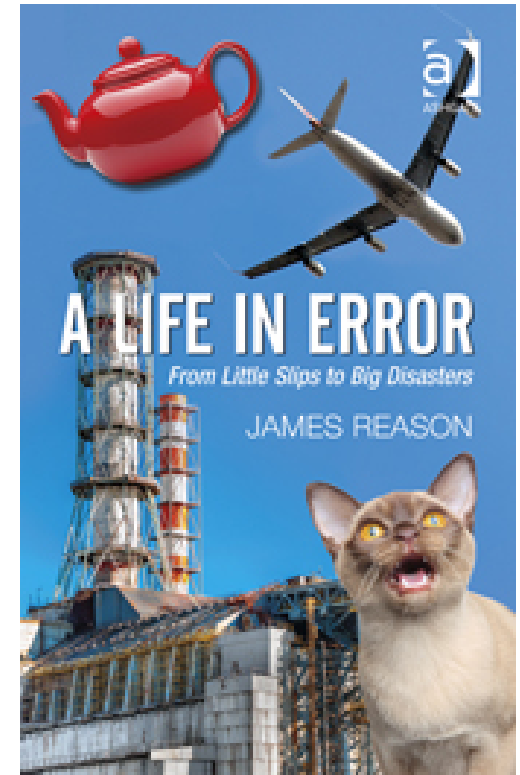
Defense Nuclear Facilities Safety Board (DNFSB) Public Hearing and Meeting

Washington, DC, August 27, 2014

My premise:

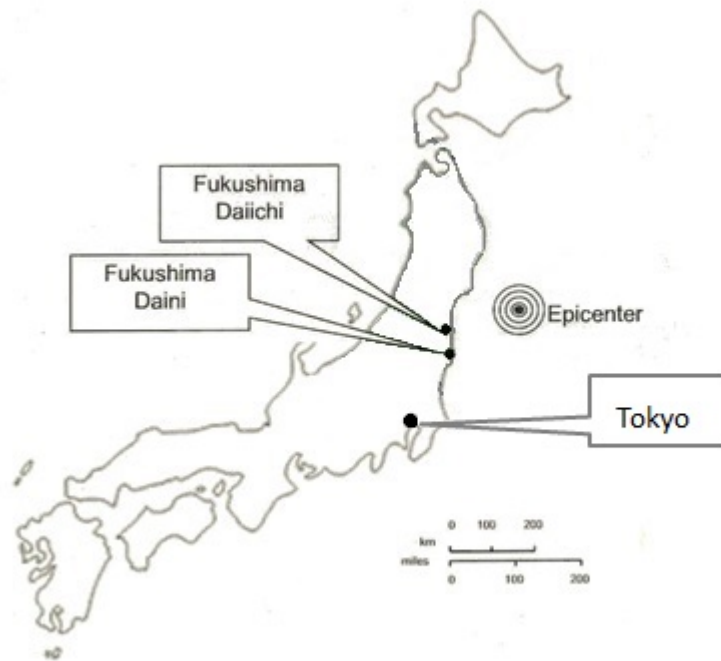
Safety Culture as a Root-Cause of a System's Common Mode Failure

- Because of their diversity and redundancies, the defense-in-depth will be widely distributed throughout the system.
- As such, they are only collectively vulnerable to something that is equally widespread. The most likely candidate is **safety culture**.
- **It can affect all elements in a system for good or ill.**



Fukushima Accident

March 11, 2011



Loss of all power sources due to the Earthquake and Tsunami



Note:

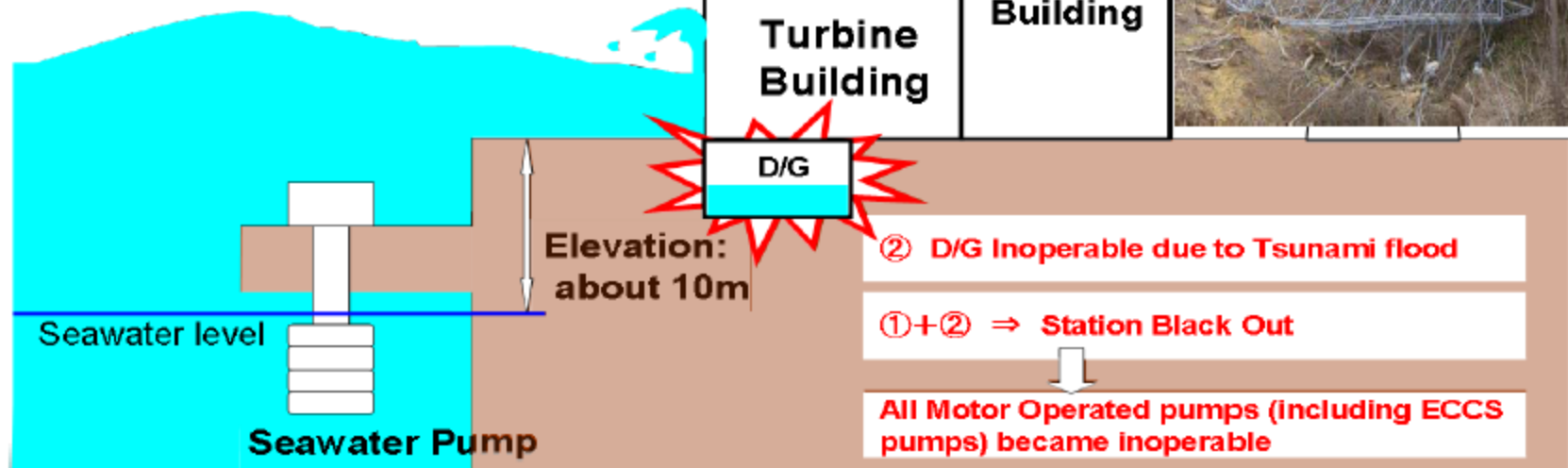
- All operating units when earthquake occurred were automatically shut down.
- Emergency D/Gs have worked properly until the Tsunami attack.

① Loss of offsite power due to the earthquake

Grid Line



Tsunami (estimated more than 10m)



Source: Nuclear and Industry Safety Agency(NISA), April 4, 2011, at IAEA

<http://www.nisa.meti.go.jp/english/files/en20110406-1-1.pdf>

NAS Fukushima Committee Report

Released June 24, 2014

Lessons Learned from the Fukushima Nuclear Accident for Improving Safety of U.S. Nuclear Plants

Lessons Learned from the Fukushima Nuclear Accident for Improving Safety of U.S. Nuclear Plants

LESSONS LEARNED FROM THE FUKUSHIMA NUCLEAR ACCIDENT FOR IMPROVING SAFETY OF U.S. NUCLEAR PLANTS

Committee on Lessons Learned from the Fukushima Nuclear Accident
for Improving Safety and Security of U.S. Nuclear Plants

Nuclear and Radiation Studies Board
Division on Earth and Life Studies

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¹ Separated from committee on November 21, 2012

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⁴ Effective July 10, 2013

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This presentation, however, should not necessarily be construed as the NAS Committee's representative position.

A few personal observations and reflections on the Fukushima accident...

**A natural disaster or an
earthquake-triggered
anthropogenic (man-made)
accident?**

WHY FUKUSHIMA WAS PREVENTABLE

James M. Acton and Mark Hibbs

NUCLEAR POLICY | MARCH 2012

CARNEGIE ENDOWMENT

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“the Fukushima accident was, however, **preventable**...with appropriate foresight by Japan’s authorities and industry, it appears that the accident **could have been avoided or prevented.**”

US Nuclear Regulatory Commission
Commissionaire
Dr. George Apostolakis

“the accident was not of extremely low probability, i.e., it was not “unthinkable” or “unforeseen.””

National Diet Report

Najm Meskhati
USC

The National Diet of Japan

The official report of

**The Fukushima
Nuclear Accident Independent
Investigation Commission**

Executive summary

The National Diet of Japan
**Fukushima Nuclear Accident
Independent Investigation
Commission (NAIIC)**

Excerpts from
Dr. Kiyoshi Kurokawa's "Message
From the Chairman"

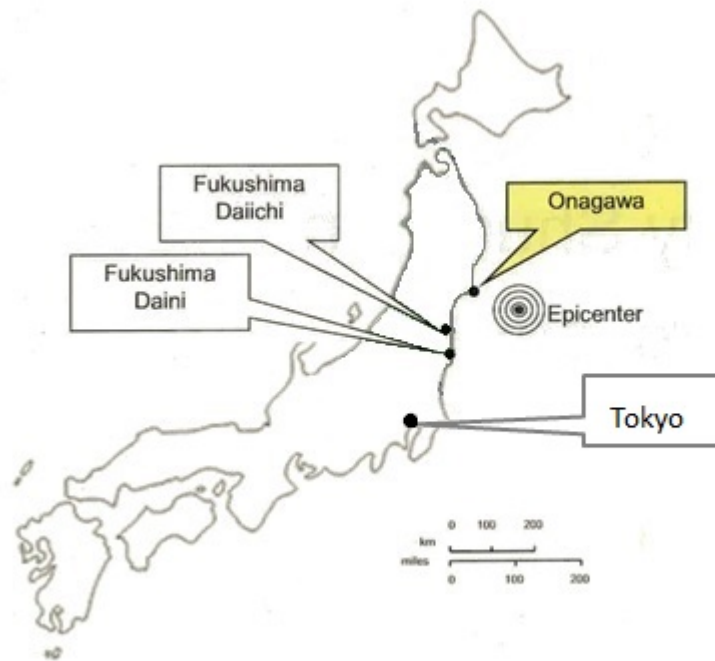
The National Diet of Japan, Fukushima Nuclear Accident Independent Investigation Commission (NAIIC)

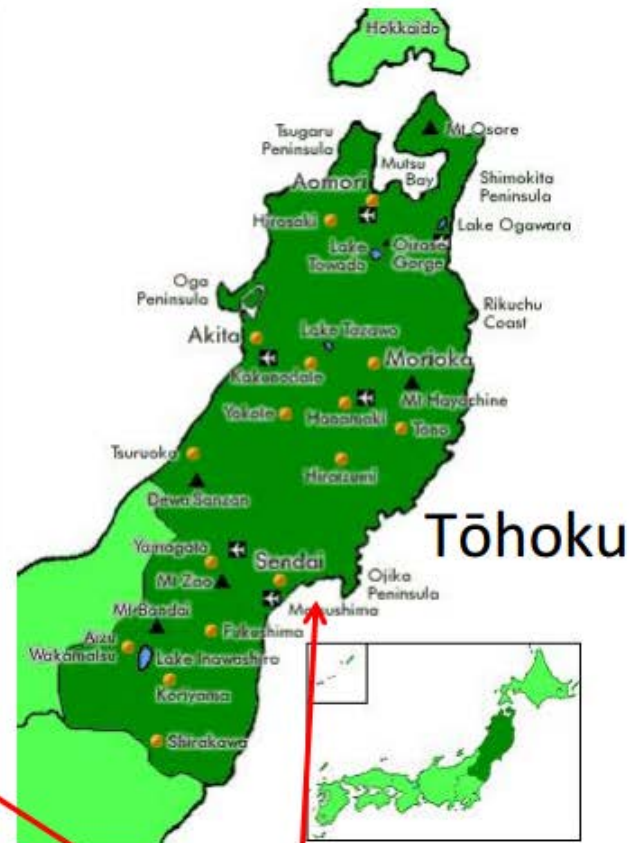
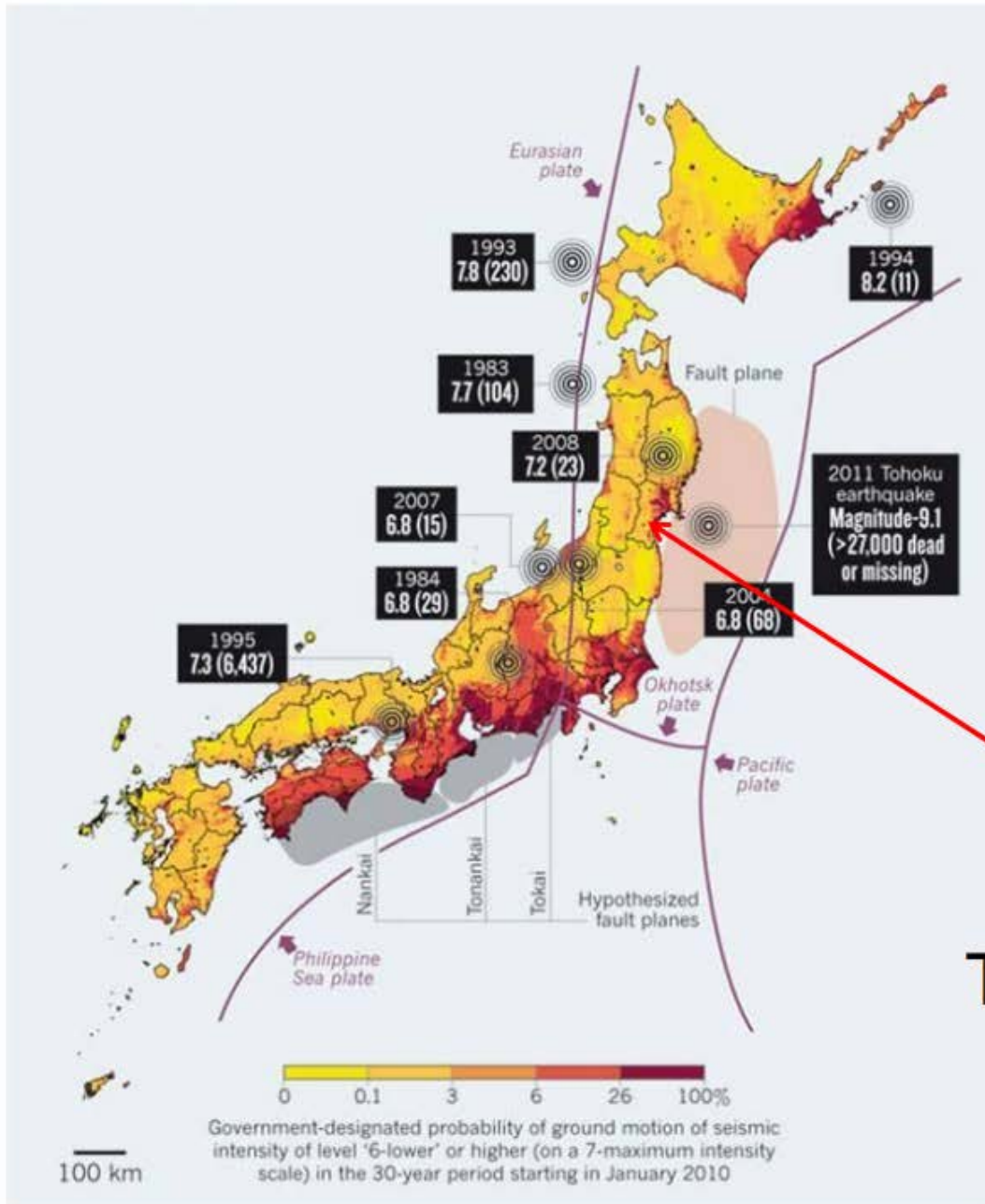
- Accident at the Fukushima Daiichi Nuclear Power Plant cannot be regarded as a natural disaster. It was a **profoundly manmade** disaster – that could and should have been **foreseen and prevented**....
- This was a disaster “**Made in Japan**”

The National Diet of Japan, Fukushima Nuclear Accident Independent Investigation Commission (NAIIC)

- Japan's nuclear industry managed to avoid absorbing the critical lessons learned from **Three Mile Island** and **Chernobyl**
- It was this mindset that led to the disaster at the Fukushima Daiichi Nuclear Plant

**Why you haven't heard about
Onagawa NPS**





The Onagawa NPS

**Nuclear Safety Culture in TEPCO and Tohoku
Electric Power Company:
A root-cause of the different fates of Fukushima
Daiichi Nuclear Power Plant and Onagawa Nuclear
Power Station**

Why You Haven't Heard About Onagawa
Nuclear Power Station after the Earthquake
and Tsunami of March 11, 2011

by:

Airi (Iris) Ryu

A research term paper for
Human Factors in Work Design (ISE
370L), Fall 2013

Daniel J. Epstein Department of Industrial
& Systems Engineering
(USC)





[ANALYSIS \(FEATURE-TYPE/ANALYSIS\)](#)

03/10/2014 - 17:56

Onagawa: The Japanese nuclear power plant that didn't melt down on 3/11

Airi Ryu, Najmedin Meshkati

"The earthquake and tsunami of March 11, 2011, were natural disasters of a magnitude that shocked the entire world. Although triggered by these cataclysmic events, the subsequent accident at the Fukushima Daiichi Nuclear Power Plant

[NAJMEDIN MESHKATI \(BIO/NAJMEDIN-MESHKATI\)](#)

[Najmedin Meshkati \(http://www-bcf.usc.edu\)](http://www-bcf.usc.edu)

March 10, 2014

cannot be regarded as a natural disaster. It was a profoundly manmade disaster—that could and should have been foreseen and prevented."

—Kiyoshi Kurokawa, "Message from the Chairman," [The Official Report of The Fukushima Nuclear Accident Independent Investigation Commission \(http://www.nirs.org/fukushima/naic_report.pdf\)](#)

Three years ago, the biggest recorded earthquake in Japanese history hit Tohoku prefecture, leaving more than 20,000 people dead or missing. On the heels of the destructive magnitude 9.0 earthquake came a tsunami that reached a run-up height of 30 meters in some areas, sweeping entire towns away in seconds. Within the affected area were three nuclear power plants: the Fukushima Daiichi and Daini nuclear power plants operated by the Tokyo Electric Power Company (Tepco), and the Onagawa Nuclear Power Station operated by the Tohoku Electric Power Company. While the three

power stations shared similar disaster conditions, nuclear reactor types, dates of operation, and an identical regulatory regime, their fates were very different. The Fukushima Daiichi plant experienced fatal meltdowns and radiation releases. Fukushima Daini was damaged by the earthquake and tsunami, but the heroic efforts and improvisations of its operators resulted in the cold shutdown of all four operating reactors. Onagawa managed to remain generally intact, despite its proximity to the epicenter of the enormous earthquake.

Everyone knows the name Fukushima, but few people, even in Japan, are familiar with the Onagawa power station. Fewer still know how Onagawa managed to avoid disaster. According to [a report by the International Atomic Energy Agency mission that visited Onagawa \(http://www.iaea.org/newscenter/focus/actionplan/reports/onagawa0413.pdf\)](#) and evaluated its performance, "the plant experienced very high levels of ground motion—the strongest shaking that any nuclear plant has ever experienced from an earthquake," but it "shut down safely" and was "remarkably undamaged."

Most people believe that Fukushima Daiichi's meltdowns were predominantly due to the earthquake and tsunami. The survival of Onagawa, however, suggests otherwise. Onagawa was only 123 kilometers away from the epicenter—60 kilometers closer than Fukushima Daiichi—and the difference in seismic intensity at the two plants was negligible. Furthermore, the tsunami was bigger at Onagawa, reaching a height of 14.3 meters, compared with 13.1 meters at Fukushima Daiichi. The difference in outcomes at the two plants reveals the root cause of Fukushima Daiichi's failures: the utility's corporate "safety culture."

Higher ground. While the Fukushima Daiichi and Onagawa plants are similar in many ways, the most obvious difference is that Tohoku Electric

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[More \(/bio/najmedin-meshkati\)](#)

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[AIRI RYU](#)

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Airi Ryu is a senior student and research assistant from Japan in the Daniel J. Epstein Department of Industrial and Systems Engineering at the University of Southern California.

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Daiichi and Onagawa

Nuclear Power Station	Type of Reactor	Commissioning Age of the Reactor/Plant	Regulatory Oversight
Daiichi	6 reactors BWR	1982	METI - NISA
Onagawa	3 reactors BWR	1988	METI- NISA

Earthquake and Tsunami at Onagawa

- Onagawa was 60 km closer than Fukushima Daiichi to the epicenter.
- Tsunami was bigger/higher at Onagawa, reaching a height of **14.3 meters**, compared with 13.1 meters at Fukushima Daiichi.

IAEA Mission to Onagawa NPS

“the closest nuclear power station to the epicenter of the enormous M9.0 GEJE...(and) due to its proximity to the earthquake source, the plant experienced very high level of ground motion – the strongest shaking that any nuclear plant has ever experienced from an earthquake.” (However it) **“shut down safely”** and was **“remarkably undamaged”** (IAEA, 2012, p.6)

Onagawa Town January, 2011



Onagawa Town March, 2011



Onagawa

Update tsunami prediction where appropriate

year	Estimated tsunami value
1970 (Filing for unit 1 license application)	3m
1987 (Filing for unit2 license application)	9.1m • Numerical Simulation • Jogan Tsunami(869) Field study on Sendai plain field ⇒conduct reinforcement of site grade slope
2002	<u>13.6m</u> • Numerical Simulation (Based upon the methods of Japan Society of Civil Engineers)



The foresight of Hirai-san in 1968



Hirai-san was apparently the only person on the entire project to push for the 14.8m tsunami wall. Many of his colleagues said that 12m would be sufficient, and they derided Hirai-san's proposal as excessive. Hirai-san's authority and drive, however, eventually prevailed, and Tōhoku EPCo spent the extra money to build the 14.8m tsunami wall. Some 40 years later, on March 11, 2011, the 13m tsunami struck the coast at Onagawa. Hirai-san remembered the past and cared about the people.

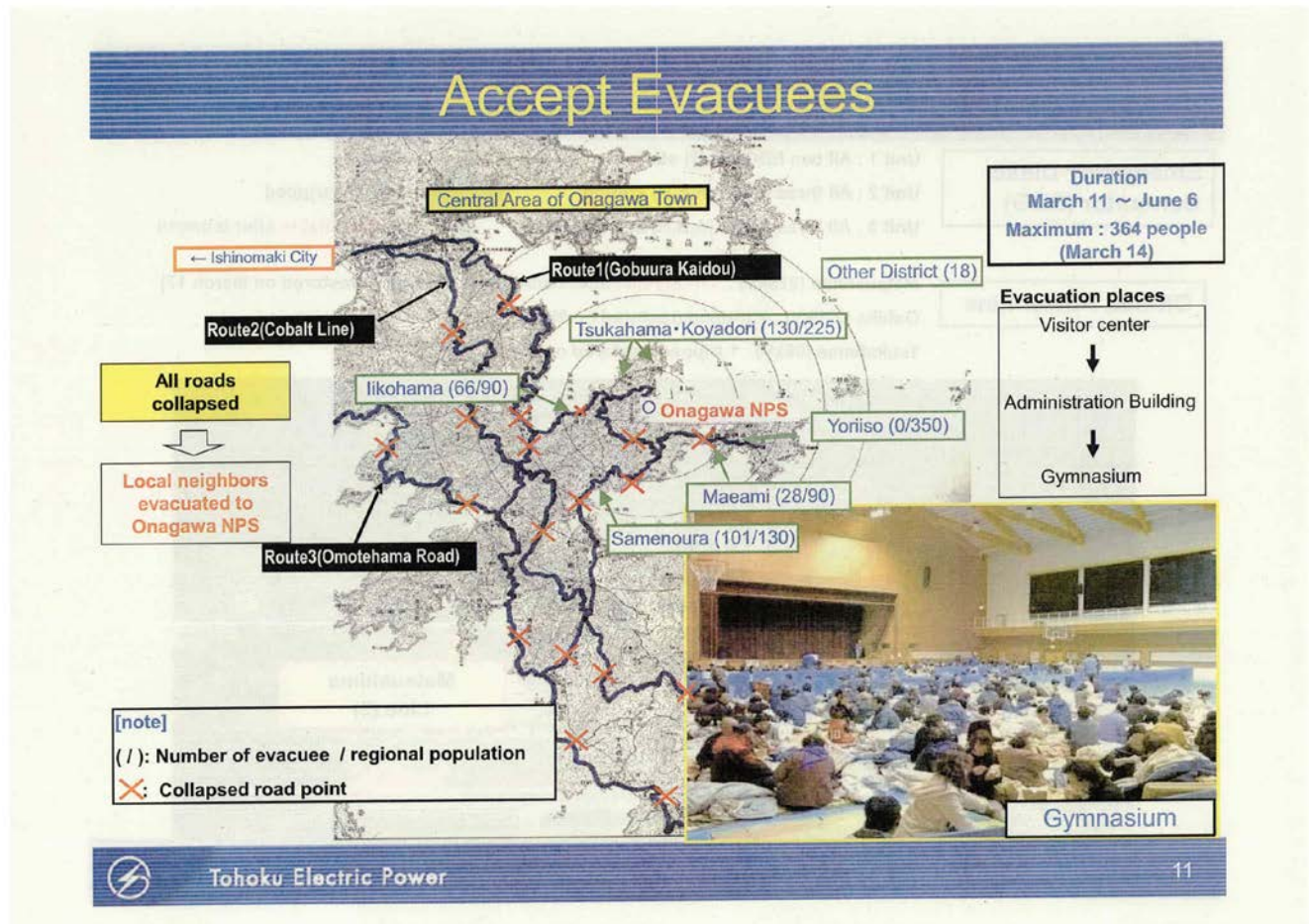


Tsunami survivors outside the Onagawa nuclear power station where they have been sheltering. Photograph: Vincent Yu/AP

As a tsunami ravaged the Japanese fishing town of Onagawa hundreds of residents fled for the safest place they knew: the local nuclear power plant.

More than two weeks later 240 remain, watching TV or playing ball games with their children in a building next to three atomic reactors. It's a startling contrast to the damaged Fukushima nuclear plant 75 miles south-east, where radiation leaks have forced an evacuation of area residents and terrified the nation.

Onagawa



Umeda-san and the Helicopter



Umeda-san, the chief nuclear officer at Tōhoku EPCo, went via helicopter to the Onagawa plant on March 12 with food, blankets, clothing, and good will for the +300 local residents who took shelter at the plant after the tsunami.

Why? Tōhoku EPCo is owned, operated, and maintained by people from Tōhoku and delivers electricity to Tōhoku.

Compare this with Fukushima Daiichi, owned by Kanto people, maintained by contract workers, and delivers electricity not to Tōhoku, but to Kanto.

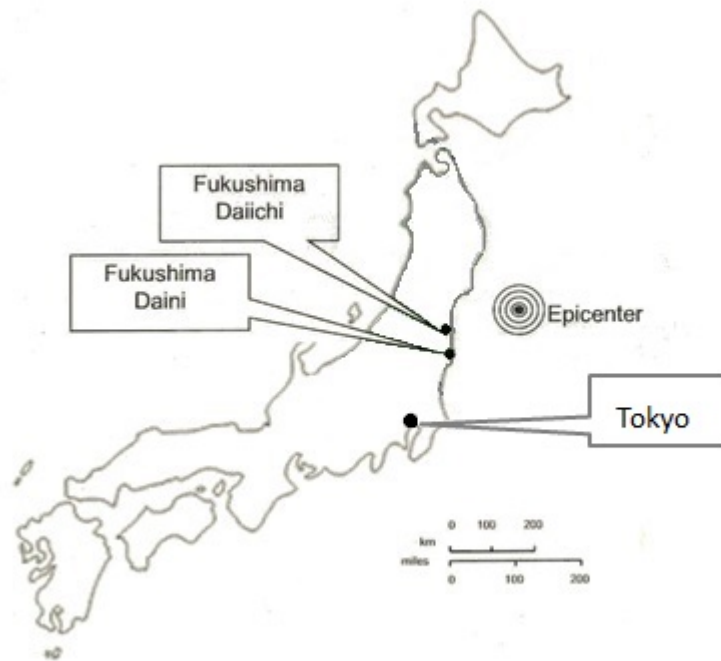
Daiichi and Onagawa

Nuclear Power Station	Utility Owner	Tsunami Risk Characterization	Initial Construction
Daiichi	TEPCO	“cascade of stupid errors that led to the disaster”	10 m elevation “underestimating tsunami level”
Onagawa	Tohoku	Proactive	14.7 m , continuously improving barriers

Tohoku's and TEPCO's Diametrically Different Responses to Tsunami Risk

- While Tohoku learned from past earthquake and tsunamis, including one in Chile on February 28, 2010, and **continuously improved its countermeasures,**
- TEPCO, however, overlooked these warnings. And according to NAIIC report, **“resorted to delaying tactics, such as presenting alternative scientific studies and lobbying.”**

A note about Daini..



Outline and layout of the power plant

Outline of the power plant

Location : 210km northeast of Tokyo.

Units 1 and 2 are in Naraha-town
and units 3 and 4 are in Tomioka-
town.

Site : 1.5km², 1.5km from north to south,
1km east to west.

	Unit 1	Unit 2	Unit 3	Unit 4
Reactor type	BWR 5 Mark II	BWR 5 Improved Mark II	BWR 5 Improved Mark II	BWR 5 Improved Mark II
Thermal power	3,293 MWt			
Electrical power	1,100 MWe			
Commercial operation	April, 1982	Feb, 1984	June, 1985	August, 1987
Fuel assembly	764			
Control rod	185			
Main constructor	Toshiba	Hitachi	Toshiba	Hitachi



NAS Fukushima Committee Report

“The Fukushima Daiichi accident reaffirms the important role that people play in responding to severe nuclear accidents and beyond-design-basis accidents more generally...

Recovery ultimately depended on the ingenuity of the people on the scene to develop and implement alternative mitigation plans in real time...

There is a growing evidence that people are a source of system resilience because of their ability to adapt creatively in response to unforeseen circumstances...

The Fukushima Daiichi accident reaffirmed that *people are the last line of defense in a sever accident.*”

(emphasis added, p. J. 1& 3)

Masuda and Daini Personnel

- Impromptu, but prudent, decision-making
- Improvisation, e.g.,
- “flexibly applying Emergency Operation Procedures (EOPs)”
- “Temporary cable of 9 km length was laid by about 200 personnel within a day. Usually this size of cable laying requires 20 personnel and more than 1 month period.”

A national hero of Japan in early 21st Century

Mr. Naohiro Masuda

Superintendent of the Fukushima Daini NPS



Admiral H.G. Rickover

Where Has This Been Done Successfully?

Navy Nuclear Program:

- 6000 reactor-years
- 130 million miles without an accident



• Emphasis on Human Performance

- Crew: 30% annual turnover, 50% under age 23, 90% non-degreed
- Operating Complexity: nuclear power, submerged under water, systems with high temp/press/voltage
- Defense in Depth: equipment and procedures controlled
- Human Performance = only variable

Admiral H.G. Rickover

On taking charge and responsibility...



“Responsibility is a unique concept. It can only reside and inhere in a single individual. You may share it with others, but your portion is not diminished. You may delegate it, but it is still with you. You may disclaim it, but you cannot divest yourself of it. Even if you do not recognize it or admit its presence, you cannot escape it. If responsibility is rightfully yours, no evasion or ignorance or passing the blame can pass the burden to someone else. Unless you can point your finger at the man responsible when something goes wrong, then you have never had anyone really responsible.”

Do you agree?

“Culture Eats Systems for Breakfast”

On the Limits of Management Based Regulation

By:

Professor Neil Gunningham and Mr. Darren Sinclair

The Australian National University

National Center for OHS Regulation, July 2009