

From: [Coe, Doug](#)
To: [Barnes, Valerie](#); [Correia, Richard](#)
Subject: RE: NEA webpage - activities post-Fukushima
Date: Monday, April 11, 2011 9:34:28 AM

Thanks Val – that's fine

From: Barnes, Valerie
Sent: Monday, April 11, 2011 8:00 AM
To: Coe, Doug; Correia, Richard
Subject: RE: NEA webpage - activities post-Fukushima

I didn't check the website, however, I gave them the SRM, which is publicly available anyway.

From: Coe, Doug
Sent: Friday, April 08, 2011 5:24 PM
To: Barnes, Valerie; Beasley, Benjamin; Coyne, Kevin; Demoss, Gary; Nicholson, Thomas; Ott, William; Peters, Sean; Salley, MarkHenry; Siu, Nathan; Stutzke, Martin
Cc: Correia, Richard
Subject: NEA webpage - activities post-Fukushima

For now, please do not post anything regarding NRC response to the Fukushima event on this NEA website. If you, or your staff, feel that something warrants posting on this website, please see Rich or I first.

Please disseminate as applicable.

Thanks,

Doug

From: Greg.LAMARRE@oecd.org [mailto:Greg.LAMARRE@oecd.org]
Sent: Friday, April 08, 2011 9:58 AM
Subject: NEA: Password restricted NEA webpage - activities post-Fukushima

Dear CSNI, PRG and WG members,

I would like to bring to your attention a new password protected NEA webpage.

It is a central page for the exchange of information regarding national activities following Fukushima entitled *Exchange of Information on Fukushima*.

This central page is accessible to all CNRA, CSNI, PRG and WG members. You can access the page-link through your password protected working area.

We will continue to post information as we are advised. I would ask that you please continue to share your national activities in response to the Fukushima event with the NEA Secretariat such that we can ensure that the site remains up-to-date and useful to members.

Thanks in advance and best regards,

XY/451

Greg



Greg Lamarre

Nuclear Safety Division

OECD Nuclear Energy Agency (NEA)

Tel.: +33 (0)1 45 24 10 53

greg.lamarre@oecd.org

Update your bookmarks!

On 1 December 2010, the NEA is moving to:

www.oecd-nea.org

From: Coe, Doug
To: Demoss, Gary; Drouin, Mary
Cc: Correia, Richard; Barnes, Valerie; Beasley, Benjamin; Coyne, Kevin; Nicholson, Thomas; Ott, William; Peters, Sean; Salley, MarkHenry; Siu, Nathan; Stutzke, Martin
Subject: FW: Operations Center Lessons Learned - Japanese Earthquake/Tsunami Event
Date: Monday, April 11, 2011 11:36:47 AM

All – please see below request for lessons learned feedback to the Ops Center and feel free to make such input as appropriate.

Gary/Mary,

I know that Mary had some useful input regarding requesting and control of staff technical support. In addition, the points-of-contact (below) may be useful to contact regarding more detailed feedback to us on the usefulness of the ESDs that Mary provided.

Doug

From: OST02 HOC

Sent: Sunday, April 10, 2011 4:26 PM

To: Abrams, Charlotte; Abu-Eid, Bobby; Adams, John; Afshar-Tous, Mugeh; Ahn, Hosung; Alemu, Bezakulu; Algama, Don; Alter, Peter; Anderson, Brian; Anderson, James; Arndt, Steven; Arribas-Colon, Maria; Ashkeboussi, Nima; Athey, George; Baker, Stephen; Ballam, Nick; Barnhurst, Daniel; Barr, Cynthia; Barss, Dan; Bazian, Samuel; Benner, Eric; Bensi, Michelle; Bergman, Thomas; Berry, Rollie; Bhachu, Ujagar; Bloom, Steven; Blount, Tom; Boger, Bruce; Bonnette, Cassandra; Borchardt, Bill; Bowers, Anthony; Bowman, Gregory; Boyce, Tom (RES); Brandon, Lou; Brandt, Philip; Brenner, Eliot; Brock, Kathryn; Brown, Cris; Brown, David; Brown, Eva; Brown, Frederick; Brown, Michael; Bukharin, Oleg; Burnell, Scott; Bush-Goddard, Stephanie; Campbell, Stephen; Camper, Larry; Carlson, Donald; Carpenter, Cynthia; Carter, Mary; Case, Michael; Casto, Greg; Cecere, Bethany; Cerverda, Margaret; Chazell, Russell; Chen, Yen-Ju; Cheng, May; Cheok, Michael; Chokshi, Niles; Chowdhury, Prosanta; Chung, Donald; Circle, Jeff; Clement, Richard; Clinton, Rebecca; Coe, Doug; Coggins, Angela; Collins, Frank; Cool, Donald; Correia, Richard; Corson, James; Costa, Arlon; Couret, Ivonne; Craffey, Ryan; Crutchley, Mary Glenn; Cruz, Zahira; Cuadrado, Leira; Dacus, Eugene; DeCicco, Joseph; Decker, David; Dembek, Stephen; Devlin, Stephanie; Dimmick, Lisa; Doane, Margaret; Dorman, Dan; Dorsey, Cynthia; Dozier, Jerry; Drake, Margaret; Droggitis, Spiros; Dube, Donald; Dudes, Laura; Eads, Johnny; Easson, Stuart; Emche, Danielle; English, Lance; Erlanger, Craig; Esmaili, Hossein; Evans, Michele; Faria-Ocasio, Carolyn; Figueroa, Roberto; Fiske, Jonathan; Flanders, Scott; Flannery, Cindy; Floyd, Daphene; Foggie, Kirk; Foster, Jack; Fragoyannis, Nancy; Franovich, Rani; Frazier, Alan; Freshman, Steve; Fuller, Edward; Galletta, Thomas; Gambone, Kimberly; Gardocki, Stanley; Gartman, Michael; Gibson, Kathy; Gitter, Joseph; Gilmer, James; Glenn, Nichole; Gordon, Dennis; Gott, William; Grant, Jeffery; Gray, Anita; Gray, Kathy; Greenwood, Carol; Grimes, Kelly; Grobe, Jack; Gross, Allen; Gulla, Gerald; Hackett, Edwin; Hale, Jerry; Hardesty, Duane; Hardin, Kimberly; Hardin, Leroy; Harrington, Holly; Harris, Tim; Harrison, Donnie; Hart, Ken; Hart, Michelle; Harvey, Brad; Hasselberg, Rick; Hayden, Elizabeth; Helton, Donald; Henderson, Karen; Hiland, Patrick; Hipschman, Thomas; Holahan, Patricia; Holahan, Vincent; Holian, Brian; Honolich, Joe; HOO Hoc; Horn, Brian; Howard, Arlette; Howard, Tabitha; Howe, Allen; Huffert, Anthony; Hurd, Sapna; Huyck, Doug; Imboden, Andy; Isom, James; Jackson, Karen; Jacobson, Jeffrey; Jervey, Richard; Jessie, Janelle; Johnson, Don; Johnson, Michael; Jolicoeur, John; Jones, Andrea; Jones, Cynthia; Jones, Henry; Kahler, Carolyn; Kammerer, Annie; Karas, Rebecca; Kauffman, John; Khan, Omar; Kolb, Timothy; Kotzalas, Margie; Kowalczyk, Jeffrey; Kratchman, Jessica; Kugler, Andrew; Lamb, Christopher; Lane, John; Larson, Emily; Laur, Steven; LaVie, Steve; Lewis, Robert; Li, Yong; Lichtz, Taylor; Lising, Jason; Lombard, Mark; Lovell, Louise; Lubinski, John; Lui, Christiana; Lukes, Kim; Lynch, Jeffery; Ma, John; Mamish, Nader; Manahan, Michelle; Marksberry, Don; Marshall, Jane; Masao, Nagai; Maupin, Cardelia; Mayros, Lauren; Mazaika, Michael; McConnell, Keith; McCoppin, Michael; McDermott, Brian; McGinty, Tim; McGovern, Denise; McIntyre, David; McMurtray, Anthony; Merritt, Christina; Meyer, Karen; Layton, Michael; Miller, Charles; Miller, Chris; Milligan, Patricia; Miranda, Samuel; Mohseni, Aby; Moore, Scott; Morlang, Gary; Morris, Scott; Mroz (Sahm), Sara; Munson, Clifford; Murray, Charles; Musico, Bruce; Nerret, Amanda; Nguyen, Caroline; Norris, Michael; Norton, Charles; Nosek, Andrew;

44/452

Opara, Stella; Ordaz, Vonna; Orr, Mark; Owens, Janice; Padovan, Mark; Parillo, John; Patel, Jay; Patel, Pravin; Patrick, Mark; Perin, Vanice; Pope, Tia; Powell, Amy; Purdy, Gary; Quinlan, Kevin; Raddatz, Michael; Ragland, Robert; Ralph, Melissa; Ramsey, Jack; Reed, Elizabeth; Reed, Sara; Reed, Wendy; Reeves, Rosemary; Reis, Terrence; Resner, Mark; Riley (OCA), Timothy; Riner, Kelly; Rini, Brett; Roach, Edward; Robinson, Edward; Rodriguez-Luccioni, Hector; Roggenbrodt, William; Ropon, Kimberly; Rosales-Cooper, Cindy; Rosenberg, Stacey; Ross-Lee, MaryJane; Roundtree, Amy; Ruland, William; Russell, Tonya; Ryan, Michelle; Salay, Michael; Salter, Susan; Salus, Amy; Sanfilippo, Nathan; Santos, Daniel; Scarbrough, Thomas; Schaperow, Jason; Schmidt, Duane; Schmidt, Rebecca; Schoenebeck, Greg; Schrader, Eric; Schwartzman, Jennifer; Seber, Dogan; See, Kenneth; Shane, Raeann; Shea, James; Shepherd, Jill; Sheron, Brian; Skarda, Raymond; Skeen, David; Sloan, Scott; Smiroldo, Elizabeth; Smith, Brooke; Smith, Stacy; Smith, Theodore; Solorio, Dave; Stahl, Eric; Stang, Annette; Stark, Johnathan; Steger (Tucci), Christine; Stieve, Alice; Stone, Rebecca; Stransky, Robert; Sturz, Fritz; Sullivan, Randy; Summers, Robert; Sun, Casper; Susco, Jeremy; Takacs, Michael; Tappert, John; Tegeler, Bret; Temple, Jeffrey; Thaggard, Mark; Thomas, Eric; Thorp, John; Tiruneh, Nebiyu; Tobin, Jennifer; Trefethen, Jean; Tschiltz, Michael; Turtill, Richard; Uhle, Jennifer; Valencia, Sandra; Vaughn, James; Velazquez-Lozada, Alexander; Vick, Lawrence; Virgilio, Martin; Virgilio, Rosetta; Ward, Leonard; Ward, William; Wastler, Sandra; Watson, Bruce; Webber, Robert; Weber, Michael; White, Bernard; Wiggins, Jim; Williams, Donna; Williams, Joseph; Williams, Tamera; Williamson, Linda; Willis, Dori; Wimbush, Andrea; Wittick, Brian; Wray, John; Wright, Lisa (Gibney); Wright, Ned; Wunder, George; Young, Francis; Zimmerman, Jacob; Zimmerman, Roy

Subject: Operations Center Lessons Learned - Japanese Earthquake/Tsunami Event

Good Afternoon,

Please provide any lessons learned regarding your experiences and potential improvements from your time in the Operations Center during the Japanese Earthquake/Tsunami Event response in the Operations Center by COB, Friday, April 22, 2011.

There are several ways to provide your lessons learned:

1. Send an e-mail to your team response program manager:
 - a. Executive Team (ET) and Executive Support Team (EST) positions: Jeff Grant (Jeffery.Grant@nrc.gov)
 - b. Reactor Safety Team (RST) positions: Rick Hasselberg/Peter Alter (Rick.Hasselberg@nrc.gov; Peter.Alter@nrc.gov)
 - c. Protective Measures Team (PMT) positions: Lou Brandon (Lou.Brandon@nrc.gov)
 - d. Liaison Teams: Jeff Temple (Jeffrey.Temple@nrc.gov)
2. Within WebEOC
 - a. In Operations Center – click on icon on desktop
 - b. From office or via Citrix, open Internet Explorer and type in the following IP address in the URL: 148.184.213.135
 - c. Once logged in, on the main control panel under Menus, select HOC Menu. Then click on the board entitled “Comments and Issues.” Then click “New Entry” button (upper right corner). Type in your comments or issues and/or your Suggestions for improvement in the appropriate boxes. Click Save when finished.

Thank You,
OST02/01

Coe, Doug

From: Correia, Richard
Sent: Monday, April 11, 2011 12:30 PM
To: Sheron, Brian; Uhle, Jennifer; Case, Michael; Richards, Stuart; Gibson, Kathy; Scott, Michael; Coe, Doug; Valentin, Andrea
Subject: FW: OUO -- 1200 EDT (April 11, 2011) USNRC Earthquake-Tsunami Update

FYI

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: LIA08 Hoc
Sent: Monday, April 11, 2011 12:20 PM
To: Correia, Richard
Subject: RE: OUO -- 1200 EDT (April 11, 2011) USNRC Earthquake-Tsunami Update

Hi Rich-

It is going to once a day...decision made today to move that once a day release time to NOON EDT. The Noon distribution allows us to incorporate the most recent information from the Japan Site team in a pattern that will best support the team in Japan.

Hope that helps!
LisaG

Lisa Gibney Wright
Liaison Team Coordinator
US Nuclear Regulatory Commission
Email: lia08.hoc@nrc.gov
Desk Ph: 301-816-5185

From: Correia, Richard
Sent: Monday, April 11, 2011 12:13 PM
To: LIA08 Hoc; Temple, Jeffrey
Subject: FW: OUO -- 1200 EDT (April 11, 2011) USNRC Earthquake-Tsunami Update

Jeff,

There was discussion Saturday to send these status reports out once/day. Any updated info on following that or other guidance?

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

44/453

From: LIA07 Hoc

Sent: Monday, April 11, 2011 12:04 PM

Subject: OOU -- 1200 EDT (April 11, 2011) USNRC Earthquake-Tsunami Update

Attached, please find a 1200 EDT, April 11, 2011, status update from the US Nuclear Regulatory Commission's Emergency Operations Center regarding the impacts of the earthquake/tsunami.

Starting today, the NRC is transitioning a great portion of its response support efforts to its line organizations, resulting in a reduction in staffing at the Headquarters Operations Center. As such, we will only be issuing the status update once a day at 1200 EDT. The timing and frequency of the updates may change to support evolving needs of the NRC Site Team in Japan.

Please note that this information is "Official Use Only" and is not intended to be shared with other stakeholders without NRC approval.

Please call the NRC's Headquarters Operations Officer at 301-816-5100 with questions.

Thank you,
Sara

Sara Mroz
US Nuclear Regulatory Commission
LIA07.HOC@nrc.gov (Operations Center)

From: Hurd, Sapna
To: RES Distribution
Subject: Japan Relief Fundraiser
Date: Monday, April 11, 2011 3:41:41 PM
Attachments: japan_relief.pptx

All -

In an effort to raise money for the people devastated by the earthquake in Japan, RES will be holding a fundraising event during the **first week of May (2nd-6th)**. Baked goods will be available for donations from **12:00 – 12:45** in the front office reception area on the 6th floor. Donations can also be given directly to Sapna Hurd or Tia Pope between the hours of 10 a.m. – 4 p.m. Volunteers are needed for the bake sale; please contact Sapna or Tia if interested.

*** All proceeds from the fundraisers will go directly to Red Cross ***

- Thank You -

Sapna Hurd/Tia Pope

YH/454

Attachment japan_relief.ppsx (83966 Bytes) cannot be converted to PDF format.

Coe, Doug

Subject: Discuss DRA review of Previous SFP Pool Work
Location: CSB 4-A04 (Rich's Office)

Start: Mon 4/11/2011 4:00 PM
End: Mon 4/11/2011 4:45 PM
Show Time As: Tentative

Recurrence: (none)

Meeting Status: Not yet responded

Organizer: Coyne, Kevin
Required Attendees: Correia, Richard; Tobin, Margaret; Helton, Donald; Coe, Doug; Stutzke, Martin



Past Spent Fuel Risk Studies a...
DSA SF dRisk Study - Comments

The purpose of this meeting is to discuss the preliminary results from DRA review of previous risk studies and draft the DSA spent fuel pool risk plan in preparation for Tuesday meeting with other RES divisions. Background information attached. Don and Maggie did some great work pulling the past work together into a coherent framework and offering insights on the previous DSA plan. Other questions to consider going forward:

1. What is the real objective of doing this SFP risk study? We currently see two possible outcomes: (1) support regulatory decision-making (e.g., new rules/requirements, back fitting), and (2) general information study to provide background for future work and support communication with internal and external stakeholders. The currently stated objectives (at least as understood by us at a staff level) do not seem clear right now, but if the purpose is to support regulatory decision-making, it would seem better to let the risk assessment process systematically guide the identification of possible risk-mitigation options, rather than pre-supposing that moving fuel off to an ISFSI pad is the only option.
2. Any risk study would be incomplete without better knowledge about what happened in Japan – without good information about how the SFP(s) at Fukushima were compromised, we cannot make a concrete advancement in the state of knowledge for this issue.
3. This should be coordinated with the Level 3 study – the connection is not clear right now, other than the fact that the Level 3 PRA is intended to consider these issues

Anyway, this meeting should able us align our thinking in DRA to support a more fruitful exchange with DSA on Tuesday...

44 | 455

From: [Temple, Jeffrey](#)
To: [Correia, Richard](#)
Subject: RE: USNRC Earthquake/Tsunami Status Update: 0430 EDT, April 11, 2011
Date: Monday, April 11, 2011 8:53:19 PM

Thanks Rich. Now the sox are 2 and 6. Lets hope the rest of the year is better. Status reports should be once a day starting Tuesday. We tried to pare it down to a two pager, but got shot down. Jeff

From: Correia, Richard
Sent: Monday, April 11, 2011 7:34 AM
To: Temple, Jeffrey; LIA08 Hoc
Subject: FW: USNRC Earthquake/Tsunami Status Update: 0430 EDT, April 11, 2011

Good morning Jeff. Saturday night we (ET & LT) with concurrence from OEDO that the status reports would continue to be updated in its current form and content but only be issued once per day. Is that what you understand as of this morning?

PS...Sox blanked the Yanks!

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: LIA07 Hoc
Sent: Monday, April 11, 2011 4:29 AM
To: LIA07 Hoc
Subject: USNRC Earthquake/Tsunami Status Update: 0430 EDT, April 11, 2011

Attached, please find a 0430 EDT, April 11, 2011 status update from the US Nuclear Regulatory Commission's Emergency Operations Center regarding the impacts of the earthquake/tsunami.

Please note that this information is "Official Use Only" and is only being shared within the federal family.

Please call the Headquarters Operations Officer at 301-816-5100 with questions.

Yen

Yen Chen
Executive Briefing Team Coordinator
US Nuclear Regulatory Commission
LIA07.HOC@nrc.gov (Operations Center)

YX | 45.6

From: Szabo, John
To: Correia, Richard
Subject: RE: fund raising for Japanese
Date: Tuesday, April 12, 2011 8:25:31 AM

Richard,

As noted in the Announcement last week from HR, OPM has granted Federal agencies permission to conduct fundraisers for the Red Cross to aid victims of the Japanese earthquake/tsunami. Therefore, you or your office could hold such a fundraiser during your lunch break.

From: Correia, Richard
Sent: Tuesday, April 12, 2011 8:23 AM
To: Szabo, John
Subject: fund raising for Japanese

Good morning John,

Are NRC employees allowed to have a fund raiser for the Red Cross to help the Japanese impacted by the recent earthquake and tsunami? The activity would be on NRC premises during the 45 minute lunch break period.

thanks

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

YY/457

Subject: Hearing: Japan at 2:45pm - Senate Committee on Environment and Public Works & Subcommittee on Clean Air and Nuclear Safety

Location: Dirksen 406

Start: Tue 4/12/2011 12:00 AM
End: Wed 4/13/2011 12:00 AM
Show Time As: Free

Recurrence: (none)

Meeting Status: Accepted

Organizer: CommissionCalendar Resource

Required Attendees: Apostolakis, George; Ash, Darren; Blake, Kathleen; Borchardt, Bill; Bozin, Sunny; Bubar, Patrice; Burns, Stephen; Cianci, Sandra; Commission_Hearing_Room; Crawford, Carrie; Franovich, Mike; GBJGroupCalendar Resource; GEA_Daily_Cal Resource; GEA_Staff_Daily Resource; Harves, Carolyn; Hasan, Nasreen; Hayden, Elizabeth; Herr, Linda; Jaczko, Gregory; Joosten, Sandy; Kock, Andrea; Lepre, Janet; Muesle, Mary; Nieh, Ho; Pulley, Deborah; Sharkey, Jeffrey; Svinicki, Kristine; Taylor, Renee; Temp, WCO; Temp, WDM; Vietti-Cook, Annette; Virgilio, Martin; Weber, Michael

When: Tuesday, April 12, 2011 12:00 AM to Wednesday, April 13, 2011 12:00 AM (GMT-05:00) Eastern Time (US & Canada).

Where: Dirksen 406

Note: The GMT offset above does not reflect daylight saving time adjustments.

~~*~*~*~*~*~*~*~*

Senate Committee on Environment and Public Works and its Subcommittee on Clean Air and Nuclear Safety

Title of Hearing: Review of the Nuclear Emergency in Japan and Implications for the U.S.

Date/Time: Tuesday, April 12, 2011, at 2:45pm

Location: Dirksen room 406

44/458

Coe, Doug

From: Correia, Richard
Sent: Tuesday, April 12, 2011 8:55 AM
To: Barnes, Valerie; Beasley, Benjamin; Coe, Doug; Coyne, Kevin; Demoss, Gary; Hudson, Daniel; Ott, William; Peters, Sean; Salley, MarkHenry; Hudson, Daniel; Nicholson, Thomas; Siu, Nathan; Stutzke, Martin
Subject: FW: List of Issues and Research Areas from Japanese Event
Attachments: Potential Long term Issues Rev1.docx

All,

Brett Rini has compiled and sorted RES staff input (attached) for the Japan events task force's consideration. Please take a look at his list and annotate any changes/corrections/clarifications keeping in mind how the task force will interpret what will be sending them (i.e., will they understand what we are asking them to consider).

Please send your comments/additions/clarifications back to me and Doug.

thanks

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Rini, Brett
Sent: Monday, April 11, 2011 5:27 PM
To: Case, Michael; Richards, Stuart; Correia, Richard; Coe, Doug; Gibson, Kathy; Scott, Michael; Valentin, Andrea
Cc: Sheron, Brian; Uhle, Jennifer
Subject: List of Issues and Research Areas from Japanese Event

Division Directors,

Please find attached a list of possible issues and research areas to follow-up on as a result of the Japanese earthquake. I compiled the input I received from your divisions along with a document that Brian sent me and classified the recommendations into various areas (e.g., electrical, severe accidents, external events).

Please review the attached document and let me know if you have any additional thoughts or changes.

Thanks,

Brett

Brett A. Rini
Technical Assistant
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
(301)251-7615
Brett.Rini@nrc.gov

YY/459

Potential Long term Issues & Research Areas as a Result of Japanese Earthquake/Tsunami and Impact on Nuclear Power Plants

Electrical Power / Station Black-out

- Assess plant response to long-term loss of onsite and offsite electrical power, as well as capabilities for mitigation (DE)
- Evaluate battery discharge duration when operated under light load (DE)
- Do we need to revisit the need for non-AC dependent hydrogen igniters on IC plants?
- Do we need AC-powered (with battery backup) hydrogen igniters in reactor buildings and/or in the vicinity of SFPs?
- Do plants have EDGs and their associated fuel tanks sufficiently protected from natural phenomena, especially floods?
- Assess the feasibility of licensees developing procedures to bring in portable electric generators to the site to a prepared location, and connecting the generators to the plant electric system. (DE)
- Assess the feasibility of developing procedures to bring in a 125 VDC battery bank and connect it to the plant DC system. (DE)
- Re-assess SBO capabilities at U.S. plants (DE)
- Should SBO coping strategies be seismically qualified to help mitigate beyond design basis seismic events where restoration of offsite power could be delayed beyond the coping time.

Instrumentation & Controls

- Do we have sufficient instrumentation in plants to accurately assess plant conditions following an accident, including severe accidents (e.g., water levels at various locations)? Is the instrumentation sufficiently robust to survive in the accident conditions?
- Is there additional instrumentation that would be of use to help manage a severe accident, such as hydrogen sensors, and would additional measures be necessary to ensure they are viable during a severe accident.
- Consider the need for additional severe accident monitoring instrumentation. Consideration should be given to providing for remote readings from the instrumentation at locations away from the unit. Wireless technology could potentially minimize the cost involved. (DE)
- Reassessment of instrumentation that can provide details on the progression of a severe accident; include remote monitoring of temperatures, pressures and radiation levels using high-capacity (long term) batteries (DE)

Reactor Pressure Vessel & Reactor Coolant System

- Performance issues of degraded/aged components: (DE)
 - Thermal loading: thermal shock, thermal transients
 - Pressure loading: explosive loadings, from thermal transients
- Components/Structures/Materials Performance in Severe or Beyond Design Basis Accidents: (DE)
 - Pumps/Valves
 - Seismic loading
- Weld Residual Stress Compendia: (DE)
 - Database of residual stresses of nuclear components: measurements & model results

- Materials research on the impact of lake/river/sea water used as makeup water to the reactor coolant system and SFP during an accident and impact on subsequent establishment of recirculation. (DE)

Containment

- PWR Containments do not have filtered vents. It is also not clear if they have vents that can be operated without AC power. Consider evaluating the benefits of putting a filtered vent on a PWR containment, along with vents that can be actuated without AC power (e.g. compressed air).
- reevaluate the need for filtered containment venting (DE)
- GSI-191 impact from seawater (DE)
- Assess coatings in the severe accident environment (DE)

Severe Accidents & Mitigation

- Effectiveness of SAMGs and EDMGs provisions (including operator training) (DRA)
- Develop SAMGs that include procedures for a containment breach (DE)
- Assess effects of high general radiation levels from a core melt on the ability for personnel to man control rooms and implement SAMGs (DE)
- Assess the need for additional regulatory guidance for severe accidents (DE)
- Review Severe Accident Management Guidelines/Emergency Operations Plans (DE)
 - Check core and spent fuel cooling procedures
 - Identify any materials issues with the cooling procedures (use of salt/river water in an emergency)
- Do U.S. plants have the capability to inject ultimate heat sink water? How much time do plants with cooling ponds, like Palo Verde, have if they injected their ponds? Does that affect long term cooling strategies?
- Emergency H₂ venting and whether current US plant configurations could lead to pockets of H₂ in areas not covered by H₂ igniters or recombiners, that give rise to explosive power sufficient to damage BWR secondary containments. (DRA) Adequacy and placement of hydrogen recombiners/igniters (DE)
- Are there accident management strategies in place for lower vessel flooding, and how well do we understand whether lower vessel flooding will work to retain a molten core inside the vessel?
- Fukushima 3 had several MOX fuel assemblies in it. How would a core with more or a full load of MOX assemblies affect the outcome of severe accidents?

Spent Fuel Pools / Independent Spent Fuel Storage Installations

- Is there a justifiable cost-benefit to off-loading from spent fuel pools all of the fuel that can be safely stored in dry casks? Removing all of the fuel that can be safely loaded in casks will not substantially reduce the heat load in the pool, but removing the fuel will increase the water volume in the pool. This will provide more time to boil off and uncover in an SBO. Also, spreading the fuel out in the pool will enhance cooling in the event of an uncover (e.g., no radiation heat source from adjacent assemblies) and may prevent or substantially delay melting.
- Develop a code which would consider the fuel loaded into a SFP, the location of the fuel within the SFP, the fuel burn-up and the decay time of each bundle, and then calculate

whether exposure of the fuel to air would result in heat-up sufficient to result in fission product release to the environment. (DE)

- Assess the practicality of requiring a water makeup line to the SFP which would include a standpipe some distance remote from the plant power block. Assess the practicality of adding boron to this makeup source. (DE)
- Assess alternate means available for adding cooling water to spent fuel pools at all U.S. plants, including time frames, assuming loss of all electrical power (DE)
- Spent Fuel Pool accident phenomenology (similar to core damage accident research) and the effectiveness of B.5.b provisions (DRA)
- Spent fuel pool liner/cooling systems performance - degraded conditions & seismic (DE)
- Evaluate impact of using "dirty water" in spent fuel pools (DE)
- Are there natural phenomena that can damage dry casks? Dry casks are designed for earthquakes. Do we know how well they can withstand a beyond DBA earthquake? Performance of spent fuel pools and casks in BDBAs (DE)
- Reconsider the earliest timeframe in which fuel can be moved into dry storage, particularly for SFPs not at or below grade level. (DE)

Internal Events

- Assess (or reassess) the potential impact of a major hydrogen leak from the turbine-generator, or from the hydrogen cooling system, including the hydrogen storage tanks. (DE)
- Reassess the response of licensees to in-plant fires, particularly where successful response requires a number of manual actions in a relatively short period of time. If called upon on a mid-shift with no warning, do we have assurance that the required timeline could be met? (DE)

Earthquake / Tsunami

- Revisit the scope of on-going earthquake and tsunami research. (DE)
- Response to aftershocks following a design or beyond-design basis earthquake.
- How well can we predict tsunami wave height? Can scale model testing help improve models?
- Tsunami Study—The purpose of this study would be to use modern models and techniques to assess the tsunami hazard for existing sites including ISFIs, not otherwise assessed in new reactor reviews. The study would confirm that the tsunami hazard for facilities is either appropriately considered in the licensing basis, is bounded by other natural events, or needs additional site specific bathymetric data. The study would also consider the need to validate the current NOAA model for tsunami, if necessary. (DE)

Other External Events

- Assess adequacy of current regulatory guidance for external events (DE)
- Are flooding measures, such as seals, inspected thoroughly and at an appropriate frequency based on their susceptibility to age-related degradation?
- Revisit natural disasters to confirm that plant licensing bases are still enveloped by the current science in the area. For example tornados, flooding from severe weather, etc. (DE)
- Revisit flooding from dams. Questions involving Oconee have already resulted in this area being revisited. Should we do more on dam failures and modeling the resulting flooding hazards? (DE)

- Are East and Gulf coast plants adequately protected from natural phenomena? There are reports that say that global warming is heating up the oceans, and this, in turn, spawns more violent hurricanes (e.g., Katrina). Have we conservatively estimated the storm surges associated with worst-case hurricanes that could hit the coasts, and are the plants along those coasts adequately protected from those storm surges and associated flooding?
- There are licensees on gulf and east coast sites (e.g., Waterford) that are or may be near other industrial facilities. How well are these facilities protected against extreme environmental events, and could failures (e.g. toxic gas release, explosions of flammable liquids and gases) at these facilities due to extreme environmental events render the control room at adjacent nuclear facilities uninhabitable?
- Revisit the impact of man-made disasters on plants. For example, plants located near industrial facilities such as petro-chemical. Do we remain confident that a major disaster at a nearby industrial facility will not have adverse impacts on the nuclear plant? If industrial processes at nearby facilities have changed since plant licensing, and have become more hazardous, how would we know? The impact of possible train or truck accidents involving hazardous materials is a related example. (DE)

Plant Siting

- Should plant siting consider space between units to ensure that adequate space is provided for severe accident mitigation using external equipment, such as the Bechtel pumping rig.
- For multi-unit sites, licensees are only required to mitigate the security related event at one unit under B.5.b. As a result, there may only be one piece of critical equipment to serve two or more units. Furthermore, each unit may need to carry out several strategies, such as core and spent fuel pool so the equipment may only support one strategy at a time. The B.5.b equipment including the water sources are not seismically qualified. Are additional requirements warranted?

Dose Assessment

- The Fukushima event seemed to bring out shortcomings of our dose assessment codes, particularly RASCAL. Should we re-evaluate the need for improved, easy to use radiological dose assessment codes? Evaluate other issues related to radiation protection actions and health effects (DSA)
- Review of tools and information available for making evacuation recommendations, including assessment of impacts on population of the evacuation (DE)
- Ground water contamination/transport. (DRA)

Risk Assessment

- Pursue Level III PRA (DRA)
- Common cause failure frequencies (DRA)
- Re-examination of the concept of credible event to which a facility is designed, and a cost-benefit analysis to determine if designing to lower probability events than is currently the practice would increase safety at a reasonable cost. (DSA)
- Multi-unit site risk including spent fuel (wet and dry) and consequential (linked) multiple initiating events (e.g. seismic with induced tsunami and fire, plus damage to fire suppression and safety systems from either seismic or tsunami), i.e. a Level III PRA including human reliability aspects. (DRA)

- The Fukushima event highlights those events that are considered of relatively low probability, but potentially of high consequence; particularly events for which the uncertainties of occurrence and response are relatively large. One such area may be shutdown risk. Shutdown operations involve a wide variety of unusual conditions, to which operators are not often exposed due to high capacity factors and short refueling outages. Under electric deregulation, many licensees are now very focused on completing outages on schedule. This pressure may be felt by all levels of staff at the plant. In the past, the agency elected to allow the industry to address this area via industry initiatives under the umbrella of NEI. The NRC might elect to revisit this area based on the uncertainties and the voluntary nature of past actions to address this area. (DE)

Human Factors

- SAMG Procedure Adequacy (DRA)
- Risk Communication (DRA)
- Decisionmaking (DRA)
- B.5.b Human Action credit – lowered staffing (DRA)
- Prolonged Fatigue (DRA)
- Human Action reliability (DRA)
- Safety Culture (DRA)
- Human perception of risk as incorporated into the design basis and regulations (DRA)
- Construction HRA (DRA)
- Reexamination of design basis events (DRA)
- Control room staffing and plant staffing for severe accidents (DRA)
- Reliance on automation/overriding automation (DRA)
- Have we adequately considered the human factors aspects of a severe accident. In the Fukushima case, the event has been on-going for several days, and it appears that the event will continue to require considerable licensee resources for some time. (DE)
 - What level of stress does this put on the plant responders over time and how does it affect their ability to carry out their duties? (DE)
 - For US licensees with a single nuclear unit, will they have the human resources to respond to a severe accident, which extends over weeks or months at a high intensity level? (DE)
 - Are there ways to mitigate human factors issues, such as cooperative support agreements with other utilities with units of a similar design? (DE)
- Consider what pre-planned actions should be in place if plant staff are required to evacuate the plant. (DE)

Incident Response / Coordination

- Emergency response given large area wide catastrophe and what can be expected (DRA)
- Assess onsite and offsite responder capabilities at U.S. plants (beyond B.5.b) (DE)
- Create organizational requirements and tools for reporting information during significant nuclear events internationally, perhaps as part of CNS or IAEA led effort. (DE)
- Assess NRC timing and procedures for manning NRC Ops Center in response to significant international events, perhaps using the INES scale for perspective on significance (DE)
- Assess NRC office procedures for supporting the NRC Ops Center in first few days of a crises, as well as for events of longer duration (DE)

- During the evolution of the accident at Fukushima, there was not a lot of coordination (at least initially) among various agencies (e.g., DOE and NRC). Concern was that everyone was advising the Japanese, with no coordination. In the event of another reactor accident outside of the U.S., should U.S. agencies have worked out plans for coordination beforehand? Does the international community need to coordinate better?
- It took a while before we called in industry and got an industry consortium going to interact directly with their Japanese counterparts (TEPCO). Should we encourage industry to create a standing consortium that would be poised to move in the event of another accident? Is this really a role for WANO?
- Given overwhelming media interest, define the role of NRC in communicating general information on nuclear energy to the public even if incidents occur at foreign nuclear plants (DE)

From: Coe, Doug
To: Sheron, Brian
Cc: Uhle, Jennifer; Correia, Richard; Beasley, Benjamin
Subject: REPLY: RES ITEMS OF INTEREST FOR WEEK ENDING APRIL 8, 2011
Date: Tuesday, April 12, 2011 12:00:37 PM

Brian,

The individual we spoke with last week (Mr. Kappenman) is a private consultant with "Storm Analysis Consultants" and as a member of the public has met or corresponded with OEGIB staff in the past. He also previously supported the 2008 U.S. National Academy of Sciences Report on "Severe Space Weather Events—Understanding Societal and Economic Impacts: A Workshop Report."

At his request we met with him last Thursday and he raised the issue of long term grid loss impact on NPPs. We indicated to him that this issue could fall within the scope of the ongoing Task Force review of the Japan event. At this time he has not proposed a generic issue.

However, we are preparing an input, for the post-Fukushima research list, to the Task Force regarding the possible need to further study the necessary coping duration for a long-term SBO in light of most recent data/events, including extreme solar storms. Such study might either be tied to rulemaking (e.g. SBO rule) or be a generic issue, as yet to-be-determined.

Doug

From: Sheron, Brian
Sent: Friday, April 08, 2011 3:27 PM
To: Correia, Richard; Coe, Doug
Subject: FW: RES ITEMS OF INTEREST FOR WEEK ENDING APRIL 8, 2011

Why were was the OEGIB meeting on Geomagnetic Storms? Did someone propose them as a GI?

From: Flory, Shirley
Sent: Friday, April 08, 2011 2:52 PM
To: RES Distribution; Correia, Richard
Subject: RES ITEMS OF INTEREST FOR WEEK ENDING APRIL 8, 2011

TY/460

Parks, Jazel

From: RidsResPmdaMail Resource
Sent: Tuesday, April 12, 2011 12:29 PM
To: Parks, Jazel
Subject: FW: Action Item/Instructions: FOIA/PA-2011-00184 EXPEDITED
Attachments: 2011-0184.pdf

Action
Kevin

From: Admin, Admin [mailto:foia.resource@nrc.gov]
Sent: Tuesday, April 12, 2011 11:56 AM
To: RidsEdoMailCenter Resource; RidsNmssOd Resource; NRO_FOIA Resource; RidsNrrMailCenter Resource; FOIAPANSIR Resource; RidsOcaMailCenter Resource; FOIAPAOIP Resource; Shannon, Valerie; RidsResPmdaMail Resource; R1FOIAPA RESOURCE; FOIAPAR2 Resource; RIIIFOIAPA Resource; FOIAPAR4 Resource; FOIAPASECY Resource
Cc: FOIA Resource; Blaney, Stephanie
Subject: Action Item/Instructions: FOIA/PA-2011-00184 EXPEDITED

You have been assigned action on the incoming FOIA request available at: **ADAMS ACCESSION # ML11102A017**

Offices Assigned Action on April 12, 2011

EDO;NMSS;NRO;NRR;NSIR;OCA;OIP;OPA;RES;RI;RII;RIII;RIV;SECY

(Duplicate of FOIA/PA-2011-0147 except for the dates. The dates for this FOIA request are 3/10/11-4/11/11).

Please begin processing since this is a media requester. No fee estimate required.

This request has been granted expedited processing. It must be processed ahead of all, others except for requests already determined to warrant expedition.

The OIS FOIA/PA Specialist for this request is indicated in the "cc" to this e-mail.

The FOIA/PA request should be processed in accordance with the standard instructions (How to Respond to an Initial FOIA Request) at ML060590485. You are encouraged to ask for a scoping discussion with the requester when you believe it will be beneficial. You are encouraged to ask for assistance in performing adequate ADAMS searches if you are having difficulty doing a search. Your initial estimate of search and review time and the volume of records is required within four (4) working-days from the date of this transmittal e-mail. NRC Form 496, "Report of Staff Resources for Processing FOIA/PA Requests" is now available on Informs for your use.

74/461

Coe, Doug

From: Ibarra, Jose
Sent: Tuesday, April 12, 2011 1:16 PM
To: Coe, Doug
Subject: RE: WASH 1400 Correspondence FOIA 2011-0178

Doug,
I will check with the FOIA coordinator on the transfer process. Jose

From: Coe, Doug
Sent: Tuesday, April 12, 2011 1:13 PM
To: Ibarra, Jose; Demoss, Gary; Coyne, Kevin
Subject: RE: WASH 1400 Correspondence FOIA 2011-0178

Thanks Jose,
I have no concerns about releasing either document, but since SECY originated one of them shouldn't SECY now be asked whether they have any objection to release? If you agree, you can check with the FOIA coordinator on process to transfer that item to SECY.
Doug

From: Ibarra, Jose
Sent: Monday, April 11, 2011 1:37 PM
To: Coe, Doug; Demoss, Gary; Coyne, Kevin
Subject: WASH 1400 Correspondence FOIA 2011-0178

Doug, Kevin, and Gary,
Attached are the two documents that the New York Attorney General is requesting. These files have been provided at noon by OIS so I did not have to go the microfiche drawer. I have read both documents. In one of the documents, the NRC Chairman transmitted the NRC Policy Statement to Congressmen Morris Udal, Gary Hart, and John Dingell. This Policy Statement is the subject of the other letter from SECY to the EDO. In addition the SECY memorandum suggests guidance to the staff. There is no reason that both letters cannot be public. The letter to the Congressman probably is already public. Since you are the PRA expertise, please let me know your opinions, so I can respond to the FOIA. On this FOIA we have more time that other Japanese Events relates
d FOIAs Thanks. Jose

JH/462

Coe, Doug

From: Ibarra, Jose
Sent: Tuesday, April 12, 2011 1:16 PM
To: Coe, Doug
Subject: RE: WASH 1400 Correspondence FOIA 2011-0178

Doug,
I will check with the FOIA coordinator on the transfer process. Jose

From: Coe, Doug
Sent: Tuesday, April 12, 2011 1:13 PM
To: Ibarra, Jose; Demoss, Gary; Coyne, Kevin
Subject: RE: WASH 1400 Correspondence FOIA 2011-0178

Thanks Jose,

I have no concerns about releasing either document, but since SECY originated one of them shouldn't SECY now be asked whether they have any objection to release? If you agree, you can check with the FOIA coordinator on process to transfer that item to SECY.

Doug

From: Ibarra, Jose
Sent: Monday, April 11, 2011 1:37 PM
To: Coe, Doug; Demoss, Gary; Coyne, Kevin
Subject: WASH 1400 Correspondence FOIA 2011-0178

Doug, Kevin, and Gary,
Attached are the two documents that the New York Attorney General is requesting. These files have been provided at noon by OIS so I did not have to go the microfiche drawer. I have read both documents. In one of the documents, the NRC Chairman transmitted the NRC Policy Statement to Congressmen Morris Udall, Gary Hart, and John Dingell. This Policy Statement is the subject of the other letter from SECY to the EDO. In addition the SECY memorandum suggests guidance to the staff. There is no reason that both letters cannot be public. The letter to the Congressman probably is already public. Since you are the PRA expertise, please let me know your opinions, so I can respond to the FOIA. On this FOIA we have more time that other Japanese Events relates
d FOIAs Thanks. Jose

JH/462

From: [Ibarra, Jose](#)
To: [Beasley, Benjamin](#); [Ott, William](#); [Coyne, Kevin](#); [Demoss, Gary](#); [Peters, Sean](#); [Salley, MarkHenry](#)
Cc: [Coe, Doug](#); [Correia, Richard](#)
Subject: FW: ACTION: FAQ repository for Public Distribution
Date: Tuesday, April 12, 2011 1:34:37 PM

BCs

Have you developed Q&A for the Japanese Nuclear Event? See e-mail from Mary Muessele on a consolidated public Q&A list. I am not aware of any developed DRA Q&A list. I need the information by the end of the week. Thanks. Jose

From: Rini, Brett
Sent: Tuesday, April 12, 2011 11:40 AM
To: Ramirez, Annie; Ibarra, Jose; Rivera-Lugo, Richard
Subject: RE: ACTION: FAQ repository for Public Distribution

Followup to our TA meeting. Just a reminder.

From: Rini, Brett
Sent: Wednesday, April 06, 2011 6:01 PM
To: Ramirez, Annie; Ibarra, Jose; Rivera-Lugo, Richard
Subject: ACTION: FAQ repository for Public Distribution

TAs,

The action on this ticket is to determine if your divisions have generated any Q&As that aren't listed at the site below. If they aren't listed, we need to compile them and send them to OPA. If they are listed, then we don't have any actions.

I would think this applies to all the divisions. Can you provide me input by next Wednesday?

Thanks,
Brett

From: Case, Michael
Sent: Wednesday, April 06, 2011 10:34 AM
To: Sheron, Brian; RidsResOd Resource; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource
Cc: Rini, Brett; Coe, Doug; Correia, Richard; Gibson, Kathy; Richards, Stuart; Scott, Michael
Subject: RE: FOR TICKETING?? FW: FAQ repository in NRR

I think they already did. I checked a couple (Indian Point seismic and did the Japanese underestimate) and they are the answers that were in Annie's Q&A set.

From: Sheron, Brian
Sent: Wednesday, April 06, 2011 10:01 AM
To: RidsResOd Resource; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource
Cc: Rini, Brett; Case, Michael; Coe, Doug; Correia, Richard; Gibson, Kathy; Richards, Stuart; Scott, Michael
Subject: RE: FOR TICKETING?? FW: FAQ repository in NRR

Please ticket to Brett. Brett, please work with Divisions on this.

Mike, do we/can we post Annie's seismic FAQs on this site?

From: Flory, Shirley **On Behalf Of** RidsResOd Resource
Sent: Wednesday, April 06, 2011 9:18 AM
To: Sheron, Brian; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource
Subject: FOR TICKETING?? FW: FAQ repository in NRR

Brian: Should this be ticketed?

44/463

Thanks - Shirley

From: Muesse, Mary

Sent: Tuesday, April 05, 2011 6:47 PM

To: RidsNmssOd Resource; RidsResOd Resource; RidsFsmeOd Resource; RidsNroOd Resource; RidsNsirOd Resource

Cc: Schum, Constance; Pulliam, Timothy; Valentin, Andrea; Webber, Robert; Brenner, Eliot; Hayden, Elizabeth; Rothschild, Trip; Leeds, Eric; Nelson, Robert; Markley, Michael; Oesterle, Eric; Rihm, Roger; Ellmers, Glenn; Andersen, James; Landau, Mindy; Frazier, Alan; Sealing, Donna; Ficks, Ben; Holonich, Joseph; Bowman, Gregory; Rheaume, Cynthia

Subject: FAQ repository in NRR

As you may know, NRR has established a very comprehensive SharePoint site for Frequently Asked Questions regarding the Japan event. These questions were initially intended to be used internally so that all staff responding to questions from stakeholders could provide a consistent response and so that similar questions would not have to be researched several times over. The site is located at:

<http://portal.nrc.gov/edo/nrr/dorl/japan/Shared%20Documents/Questions%20and%20Answers.aspx>

We would like to make this FAQ site available to the public as the primary consolidated site for all FAQs related to the event. To this end, I am asking your assistance by notifying us as to whether FAQs have been gathered in your office and would be appropriate for the public site. The FAQs should be sufficiently "high-level" so that they would typically be asked by a member of the public. We are not seeking very technical, detailed FAQs. They should also be FAQs that do not already appear on the SharePoint site. If your office has developed such FAQs, please send them to Beth Hayden, in OPA, who has agreed to review them to ensure they are appropriate for public release. You should then forward the OPA-approved FAQs to NRR (Eric Oesterle) for incorporation on to the SharePoint site.

Our goal is to make the site available over the course of the next week or so and then incorporate any additional OPA-vetted FAQs on to the site as soon as practicable.

Please let Mindy Landau or I know if you have any questions and thank you for your assistance and thank to NRR for this outstanding initiative!

Mary

Ibarra, Jose

From: Peters, Sean
Sent: Tuesday, April 12, 2011 1:36 PM
To: Ibarra, Jose
Subject: RE: ACTION: FAQ repository for Public Distribution

Hey Jose,

HFRB has not developed Q&As....

From: Ibarra, Jose
Sent: Tuesday, April 12, 2011 1:35 PM
To: Beasley, Benjamin; Ott, William; Coyne, Kevin; Demoss, Gary; Peters, Sean; Salley, MarkHenry
Cc: Coe, Doug; Correia, Richard
Subject: FW: ACTION: FAQ repository for Public Distribution

BCs
Have you developed Q&A for the Japanese Nuclear Event? See e-mail from Mary Muessle on a consolidated public Q&A list. I am not aware of any developed DRA Q&A list. I need the information by the end of the week. Thanks. Jose

From: Rini, Brett
Sent: Tuesday, April 12, 2011 11:40 AM
To: Ramirez, Annie; Ibarra, Jose; Rivera-Lugo, Richard
Subject: RE: ACTION: FAQ repository for Public Distribution

Followup to our TA meeting. Just a reminder.

From: Rini, Brett
Sent: Wednesday, April 06, 2011 6:01 PM
To: Ramirez, Annie; Ibarra, Jose; Rivera-Lugo, Richard
Subject: ACTION: FAQ repository for Public Distribution

TAs,

The action on this ticket is to determine if your divisions have generated any Q&As that aren't listed at the site below. If they aren't listed, we need to compile them and send them to OPA. If they are listed, then we don't have any actions.

I would think this applies to all the divisions. Can you provide me input by next Wednesday?

Thanks,
Brett

From: Case, Michael
Sent: Wednesday, April 06, 2011 10:34 AM
To: Sheron, Brian; RidsResOd Resource; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource
Cc: Rini, Brett; Coe, Doug; Correia, Richard; Gibson, Kathy; Richards, Stuart; Scott, Michael
Subject: RE: FOR TICKETING?? FW: FAQ repository in NRR

I think they already did. I checked a couple (Indian Point seismic and did the Japanese underestimate) and they are the answers that were in Annie's Q&A set.

44/464

From: Sheron, Brian

Sent: Wednesday, April 06, 2011 10:01 AM

To: RidsResOd Resource; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource

Cc: Rini, Brett; Case, Michael; Coe, Doug; Correia, Richard; Gibson, Kathy; Richards, Stuart; Scott, Michael

Subject: RE: FOR TICKETING?? FW: FAQ repository in NRR

Please ticket to Brett. Brett, please work with Divisions on this.

Mike, do we/can we post Annie's seismic FAQs on this site?

From: Flory, Shirley **On Behalf Of** RidsResOd Resource

Sent: Wednesday, April 06, 2011 9:18 AM

To: Sheron, Brian; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource

Subject: FOR TICKETING?? FW: FAQ repository in NRR

Brian: Should this be ticketed?

Thanks - Shirley

From: Muessle, Mary

Sent: Tuesday, April 05, 2011 6:47 PM

To: RidsNmssOd Resource; RidsResOd Resource; RidsFsmeOd Resource; RidsNroOd Resource; RidsNsirOd Resource

Cc: Schum, Constance; Pulliam, Timothy; Valentin, Andrea; Webber, Robert; Brenner, Eliot; Hayden, Elizabeth;

Rothschild, Trip; Leeds, Eric; Nelson, Robert; Markley, Michael; Oesterle, Eric; Rihm, Roger; Ellmers, Glenn; Andersen,

James; Landau, Mindy; Frazier, Alan; Sealing, Donna; Ficks, Ben; Holonich, Joseph; Bowman, Gregory; Rheaume, Cynthia

Subject: FAQ repository in NRR

As you may know, NRR has established a very comprehensive SharePoint site for Frequently Asked Questions regarding the Japan event. These questions were initially intended to be used internally so that all staff responding to questions from stakeholders could provide a consistent response and so that similar questions would not have to be researched several times over. The site is located at: <http://portal.nrc.gov/edo/nrr/dorl/japan/Shared%20Documents/Questions%20and%20Answers.aspx>

We would like to make this FAQ site available to the public as the primary consolidated site for all FAQs related to the event. To this end, I am asking your assistance by notifying us as to whether FAQs have been gathered in your office and would be appropriate for the public site. The FAQs should be sufficiently "high-level" so that they would typically be asked by a member of the public. We are not seeking very technical, detailed FAQs. They should also be FAQs that do not already appear on the SharePoint site. If your office has developed such FAQs, please send them to Beth Hayden, in OPA, who has agreed to review them to ensure they are appropriate for public release. You should then forward the OPA-approved FAQs to NRR (Eric Oesterle) for incorporation on to the SharePoint site.

Our goal is to make the site available over the course of the next week or so and then incorporate any additional OPA-vetted FAQs on to the site as soon as practicable.

Please let Mindy Landau or I know if you have any questions and thank you for your assistance and thank to NRR for this outstanding initiative!

Mary

Coe, Doug

From: Correia, Richard
Sent: Tuesday, April 12, 2011 2:21 PM
To: Ordaz, Vonna; White, Bernard; Wastler, Sandra; Layton, Michael; Brochman, Phil
Cc: Coe, Doug
Subject: SF Comm. briefing questions

All,

Below are the questions we received from Comm. Apostolakis' office in preparation for the 4/29 (10am) briefing. I believe someone (Bernie?) said that these would be helpful in preparing the ISFSI presentations.

Thanks for your support!

Rich

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

- (1) What are the current regulatory requirements for spent fuel pool design regarding natural disasters and accident mitigation? In particular, the requirements for infrastructure, backup power supplies, and cooling?
- (2) Following 09/11/01, what studies have been done regarding the vulnerabilities to and consequences of severe accidents and what were the results?
- (3) What additional regulatory requirements have been imposed as a result of these studies?

44/465

Parks, Jazel

From: RidsResPmdaMail Resource
Sent: Tuesday, April 12, 2011 2:52 PM
To: Parks, Jazel
Subject: FW: FOIA/PA-2011-0184

Action, Kevin

From: Blaney, Stephanie
Sent: Tuesday, April 12, 2011 2:20 PM
To: FOIAPANSIR Resource; FOIAPAOIP Resource; FOIAPAR2 Resource; FOIAPAR4 Resource; FOIAPASECY Resource; RidsEdoMailCenter Resource; RidsNmssOd Resource; NRO_FOIA Resource; RidsNrrMailCenter Resource; RidsOcaMailCenter Resource; OPA Resource; RidsResPmdaMail Resource; R1FOIAPA RESOURCE; RIIIFOIAPA Resource
Subject: FOIA/PA-2011-0184

The incoming states "after March 10th", please search for records using dates March 11th-April 11th.

Thank you,

Stephanie Blaney
FOIA/PA Specialist
FOIA/Privacy Section, Information Services Branch
Information & Records Services Division
Office of Information Services
U.S. Nuclear Regulatory Commission
301-415-6975 (Phone)
301-415-5130 (Fax)

YY/466

From: [Salley, MarkHenry](#)
To: [Correia, Richard](#)
Subject: FW: How close is your home to a nuclear plant?
Date: Tuesday, April 12, 2011 3:10:21 PM

Guess CNN does not have anything better to do.....

From: Debbie Rogers [mailto:debbie@mhatn.com]
Sent: Tuesday, April 12, 2011 2:28 PM
To: 'JR Davis'; Salley, MarkHenry
Subject: FW: How close is your home to a nuclear plant?

From: Lloyd Trundle [mailto:ltrundle@blounttn.org]
Sent: Tuesday, April 12, 2011 2:25 PM
To: Lloyd Trundle
Subject: FW: How close is your home to a nuclear plant?

Click on the line below.....
It's a little unsettling....



[How close is your home to a nuclear plant?](#)

44/467

Ibarra, Jose

From: Ibarra, Jose
Sent: Tuesday, April 12, 2011 4:00 PM
To: Beasley, Benjamin
Cc: Kauffman, John
Subject: RE: ACTION: FAQ repository for Public Distribution

Ben,
Thanks. I will talk to John tomorrow. Jose

From: Beasley, Benjamin
Sent: Tuesday, April 12, 2011 3:58 PM
To: Ibarra, Jose
Cc: Kauffman, John
Subject: RE: ACTION: FAQ repository for Public Distribution

Jose,

We are working on a big set of questions. It originated in the Ops Center and we are cleaning it up. Shelby was working on it last week and JVK has picked it up while she is away.

Ben

From: Ibarra, Jose
Sent: Tuesday, April 12, 2011 1:35 PM
To: Beasley, Benjamin; Ott, William; Coyne, Kevin; Demoss, Gary; Peters, Sean; Salley, MarkHenry
Cc: Coe, Doug; Correia, Richard
Subject: FW: ACTION: FAQ repository for Public Distribution

BCs
Have you developed Q&A for the Japanese Nuclear Event? See e-mail from Mary Muessle on a consolidated public Q&A list. I am not aware of any developed DRA Q&A list. I need the information by the end of the week. Thanks. Jose

From: Rini, Brett
Sent: Tuesday, April 12, 2011 11:40 AM
To: Ramirez, Annie; Ibarra, Jose; Rivera-Lugo, Richard
Subject: RE: ACTION: FAQ repository for Public Distribution

Followup to our TA meeting. Just a reminder.

From: Rini, Brett
Sent: Wednesday, April 06, 2011 6:01 PM
To: Ramirez, Annie; Ibarra, Jose; Rivera-Lugo, Richard
Subject: ACTION: FAQ repository for Public Distribution

TAs,

The action on this ticket is to determine if your divisions have generated any Q&As that aren't listed at the site below. If they aren't listed, we need to compile them and send them to OPA. If they are listed, then we don't have any actions.

I would think this applies to all the divisions. Can you provide me input by next Wednesday?

4/12/11 4:08

Thanks,
Brett

From: Case, Michael
Sent: Wednesday, April 06, 2011 10:34 AM
To: Sheron, Brian; RidsResOd Resource; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource
Cc: Rini, Brett; Coe, Doug; Correia, Richard; Gibson, Kathy; Richards, Stuart; Scott, Michael
Subject: RE: FOR TICKETING?? FW: FAQ repository in NRR

I think they already did. I checked a couple (Indian Point seismic and did the Japanese underestimate) and they are the answers that were in Annie's Q&A set.

From: Sheron, Brian
Sent: Wednesday, April 06, 2011 10:01 AM
To: RidsResOd Resource; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource
Cc: Rini, Brett; Case, Michael; Coe, Doug; Correia, Richard; Gibson, Kathy; Richards, Stuart; Scott, Michael
Subject: RE: FOR TICKETING?? FW: FAQ repository in NRR

Please ticket to Brett. Brett, please work with Divisions on this.

Mike, do we/can we post Annie's seismic FAQs on this site?

From: Flory, Shirley **On Behalf Of** RidsResOd Resource
Sent: Wednesday, April 06, 2011 9:18 AM
To: Sheron, Brian; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource
Subject: FOR TICKETING?? FW: FAQ repository in NRR

Brian: Should this be ticketed?

Thanks - Shirley

From: Muessle, Mary
Sent: Tuesday, April 05, 2011 6:47 PM
To: RidsNmssOd Resource; RidsResOd Resource; RidsFsmeOd Resource; RidsNroOd Resource; RidsNsrOd Resource
Cc: Schum, Constance; Pulliam, Timothy; Valentin, Andrea; Webber, Robert; Brenner, Eliot; Hayden, Elizabeth; Rothschild, Trip; Leeds, Eric; Nelson, Robert; Markley, Michael; Oesterle, Eric; Rihm, Roger; Ellmers, Glenn; Andersen, James; Landau, Mindy; Frazier, Alan; Sealing, Donna; Ficks, Ben; Holonich, Joseph; Bowman, Gregory; Rheaume, Cynthia
Subject: FAQ repository in NRR

As you may know, NRR has established a very comprehensive SharePoint site for Frequently Asked Questions regarding the Japan event. These questions were initially intended to be used internally so that all staff responding to questions from stakeholders could provide a consistent response and so that similar questions would not have to be researched several times over. The site is located at: <http://portal.nrc.gov/edo/nrr/dorl/japan/Shared%20Documents/Questions%20and%20Answers.aspx>

We would like to make this FAQ site available to the public as the primary consolidated site for all FAQs related to the event. To this end, I am asking your assistance by notifying us as to whether FAQs have been gathered in your office and would be appropriate for the public site. The FAQs should be sufficiently "high-level" so that they would typically be asked by a member of the public. We are not seeking very technical, detailed FAQs. They should also be FAQs that do not already appear on the SharePoint site. If your office has developed such FAQs, please send them to Beth Hayden, in OPA, who has agreed to review them to ensure they are appropriate for public release.

You should then forward the OPA-approved FAQs to NRR (Eric Oesterle) for incorporation on to the SharePoint site.

Our goal is to make the site available over the course of the next week or so and then incorporate any additional OPA-vetted FAQs on to the site as soon as practicable.

Please let Mindy Landau or I know if you have any questions and thank you for your assistance and thank to NRR for this outstanding initiative!

Mary

Coe, Doug

From: Rini, Brett
Sent: Tuesday, April 12, 2011 5:42 PM
To: Coe, Doug
Cc: Correia, Richard
Subject: RE: List of Issues and Research Areas from Japanese Event

Doug,

I didn't realize he was going to forward it either. I think we can continue to collect information and send an updated list at the end of the week.

I'll hold onto this until then.

Thanks,

Brett

From: Coe, Doug
Sent: Tuesday, April 12, 2011 5:24 PM
To: Rini, Brett
Cc: Correia, Richard
Subject: FW: List of Issues and Research Areas from Japanese Event

Brett – I didn't realize Brian was going to send the RES list to the Task Force today. Please see some additional suggestions from DRA (attached).

Doug

From: Siu, Nathan
Sent: Tuesday, April 12, 2011 11:28 AM
To: Correia, Richard; Coe, Doug
Subject: RE: List of Issues and Research Areas from Japanese Event

Rich/Doug –

Here are some potential additions stemming from things I've heard about Fukushima. Some of them may be implicitly included in existing bullets but I thought they're worth bringing out, given the nature of the list. Some also come from thoughts following NRC's post-9/11 work. I haven't vetted these with other folks – not sure of the timeline Brett is working to – but would be happy to discuss.

Nathan

From: Correia, Richard
Sent: Tuesday, April 12, 2011 8:55 AM
To: Barnes, Valerie; Beasley, Benjamin; Coe, Doug; Coyne, Kevin; Demoss, Gary; Hudson, Daniel; Ott, William; Peters, Sean; Salley, MarkHenry; Hudson, Daniel; Nicholson, Thomas; Siu, Nathan; Stutzke, Martin
Subject: FW: List of Issues and Research Areas from Japanese Event

All,

Brett Rini has compiled and sorted RES staff input (attached) for the Japan events task force's consideration. Please take a look at his list and annotate any changes/corrections/clarifications keeping in mind how the task force will interpret what will be sending them (i.e., will they understand what we are asking them to consider).

Please send your comments/additions/clarifications back to me and Doug.

thanks

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Rini, Brett
Sent: Monday, April 11, 2011 5:27 PM
To: Case, Michael; Richards, Stuart; Correia, Richard; Coe, Doug; Gibson, Kathy; Scott, Michael; Valentin, Andrea
Cc: Sheron, Brian; Uhle, Jennifer
Subject: List of Issues and Research Areas from Japanese Event

Division Directors,

Please find attached a list of possible issues and research areas to follow-up on as a result of the Japanese earthquake. I compiled the input I received from your divisions along with a document that Brian sent me and classified the recommendations into various areas (e.g., electrical, severe accidents, external events).

Please review the attached document and let me know if you have any additional thoughts or changes.

Thanks,

Brett

Brett A. Rini
Technical Assistant
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
(301)251-7615
Brett.Rini@nrc.gov

Ibarra, Jose

From: Coyne, Kevin
Sent: Tuesday, April 12, 2011 7:04 PM
To: Ibarra, Jose
Subject: RE: ACTION: FAQ repository for Public Distribution

None for PRAB....

From: Ibarra, Jose
Sent: Tuesday, April 12, 2011 1:35 PM
To: Beasley, Benjamin; Ott, William; Coyne, Kevin; Demoss, Gary; Peters, Sean; Salley, MarkHenry
Cc: Coe, Doug; Correia, Richard
Subject: FW: ACTION: FAQ repository for Public Distribution

BCs
Have you developed Q&A for the Japanese Nuclear Event? See e-mail from Mary Muessle on a consolidated public Q&A list. I am not aware of any developed DRA Q&A list. I need the information by the end of the week. Thanks. Jose

From: Rini, Brett
Sent: Tuesday, April 12, 2011 11:40 AM
To: Ramirez, Annie; Ibarra, Jose; Rivera-Lugo, Richard
Subject: RE: ACTION: FAQ repository for Public Distribution

Followup to our TA meeting. Just a reminder.

From: Rini, Brett
Sent: Wednesday, April 06, 2011 6:01 PM
To: Ramirez, Annie; Ibarra, Jose; Rivera-Lugo, Richard
Subject: ACTION: FAQ repository for Public Distribution

TAs,

The action on this ticket is to determine if your divisions have generated any Q&As that aren't listed at the site below. If they aren't listed, we need to compile them and send them to OPA. If they are listed, then we don't have any actions.

I would think this applies to all the divisions. Can you provide me input by next Wednesday?

Thanks,
Brett

From: Case, Michael
Sent: Wednesday, April 06, 2011 10:34 AM
To: Sheron, Brian; RidsResOd Resource; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource
Cc: Rini, Brett; Coe, Doug; Correia, Richard; Gibson, Kathy; Richards, Stuart; Scott, Michael
Subject: RE: FOR TICKETING?? FW: FAQ repository in NRR

I think they already did. I checked a couple (Indian Point seismic and did the Japanese underestimate) and they are the answers that were in Annie's Q&A set.

44/470

From: Sheron, Brian
Sent: Wednesday, April 06, 2011 10:01 AM
To: RidsResOd Resource; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource
Cc: Rini, Brett; Case, Michael; Coe, Doug; Correia, Richard; Gibson, Kathy; Richards, Stuart; Scott, Michael
Subject: RE: FOR TICKETING?? FW: FAQ repository in NRR

Please ticket to Brett. Brett, please work with Divisions on this.

Mike, do we/can we post Annie's seismic FAQs on this site?

From: Flory, Shirley **On Behalf Of** RidsResOd Resource
Sent: Wednesday, April 06, 2011 9:18 AM
To: Sheron, Brian; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource
Subject: FOR TICKETING?? FW: FAQ repository in NRR

Brian: Should this be ticketed?

Thanks - Shirley

From: Muessle, Mary
Sent: Tuesday, April 05, 2011 6:47 PM
To: RidsNmssOd Resource; RidsResOd Resource; RidsFsmeOd Resource; RidsNroOd Resource; RidsNsirOd Resource
Cc: Schum, Constance; Pulliam, Timothy; Valentin, Andrea; Webber, Robert; Brenner, Eliot; Hayden, Elizabeth; Rothschild, Trip; Leeds, Eric; Nelson, Robert; Markley, Michael; Oesterle, Eric; Rihm, Roger; Ellmers, Glenn; Andersen, James; Landau, Mindy; Frazier, Alan; Sealing, Donna; Ficks, Ben; Holonich, Joseph; Bowman, Gregory; Rheaume, Cynthia
Subject: FAQ repository in NRR

As you may know, NRR has established a very comprehensive SharePoint site for Frequently Asked Questions regarding the Japan event. These questions were initially intended to be used internally so that all staff responding to questions from stakeholders could provide a consistent response and so that similar questions would not have to be researched several times over. The site is located at: <http://portal.nrc.gov/edo/nrr/dorl/japan/Shared%20Documents/Questions%20and%20Answers.aspx>

We would like to make this FAQ site available to the public as the primary consolidated site for all FAQs related to the event. To this end, I am asking your assistance by notifying us as to whether FAQs have been gathered in your office and would be appropriate for the public site. The FAQs should be sufficiently "high-level" so that they would typically be asked by a member of the public. We are not seeking very technical, detailed FAQs. They should also be FAQs that do not already appear on the SharePoint site. If your office has developed such FAQs, please send them to Beth Hayden, in OPA, who has agreed to review them to ensure they are appropriate for public release. You should then forward the OPA-approved FAQs to NRR (Eric Oesterle) for incorporation on to the SharePoint site.

Our goal is to make the site available over the course of the next week or so and then incorporate any additional OPA-vetted FAQs on to the site as soon as practicable.

Please let Mindy Landau or I know if you have any questions and thank you for your assistance and thank to NRR for this outstanding initiative!

Mary

From: [Temple, Jeffrey](#)
To: [Correia, Richard](#)
Subject: RE: USNRC Earthquake/Tsunami Status Update: 0430 EDT, April 11, 2011
Date: Tuesday, April 12, 2011 9:56:59 PM

Thanks for your help. I hope I can call on you as an LT director as we move forward. Let me know when you have time to see the Sox play the O's. Jeff

From: Correia, Richard
Sent: Tuesday, April 12, 2011 7:02 AM
To: Temple, Jeffrey
Subject: RE: USNRC Earthquake/Tsunami Status Update: 0430 EDT, April 11, 2011

Thx Jeff. We move on as always. Have a great day and let's hope the SOX are on an upward trend starting today...

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Temple, Jeffrey
Sent: Monday, April 11, 2011 8:53 PM
To: Correia, Richard
Subject: RE: USNRC Earthquake/Tsunami Status Update: 0430 EDT, April 11, 2011

Thanks Rich. Now the sox are 2 and 6. Lets hope the rest of the year is better. Status reports should be once a day starting Tuesday. We tried to pare it down to a two pager, but got shot down. Jeff

From: Correia, Richard
Sent: Monday, April 11, 2011 7:34 AM
To: Temple, Jeffrey; LIA08 Hoc
Subject: FW: USNRC Earthquake/Tsunami Status Update: 0430 EDT, April 11, 2011

Good morning Jeff. Saturday night we (ET & LT) with concurrence from OEDO that the status reports would continue to be updated in its current form and content but only be issued once per day. Is that what you understand as of this morning?

PS...Sox blanked the Yanks!

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

YY/471

From: LIA07 Hoc
Sent: Monday, April 11, 2011 4:29 AM
To: LIA07 Hoc
Subject: USNRC Earthquake/Tsunami Status Update: 0430 EDT, April 11, 2011

Attached, please find a 0430 EDT, April 11, 2011 status update from the US Nuclear Regulatory Commission's Emergency Operations Center regarding the impacts of the earthquake/tsunami.

Please note that this information is "Official Use Only" and is only being shared within the federal family.

Please call the Headquarters Operations Officer at 301-816-5100 with questions.

Yen

Yen Chen
Executive Briefing Team Coordinator
US Nuclear Regulatory Commission
LIA07.HOC@nrc.gov (Operations Center)

Ibarra, Jose

From: Killian, Michelle
Sent: Wednesday, April 13, 2011 3:04 PM
To: Ibarra, Jose
Subject: RE: ACTION: FAQ repository for Public Distribution

Hi Jose,

No problem. Doing well thanks! I head out to Region I this next week to do a 3 month rotation in the Medical Branch there. I am looking forward to it. Hope all is well with you.

Thanks,

Michelle

From: Ibarra, Jose
Sent: Wednesday, April 13, 2011 3:02 PM
To: Killian, Lauren; Killian, Michelle
Subject: FW: ACTION: FAQ repository for Public Distribution

Michelle and Lauren,

I meant to send the e-mail to Lauren not Michelle. Sorry.
How are you doing Michelle?

Jose

From: Ibarra, Jose
Sent: Wednesday, April 13, 2011 2:50 PM
To: Bensi, Michelle; Killian, Michelle
Subject: FW: ACTION: FAQ repository for Public Distribution

Shelby and Michelle,

I understand that OEGIB has worked on Japanese Nuclear Event Q&As. Please see OEDO effort to put all the Japanese Nuclear Event into a Share Point site. I have sent this information to John Kauffman. See me if you have any questions. Thanks. Jose

From: Rini, Brett
Sent: Wednesday, April 06, 2011 6:01 PM
To: Ramirez, Annie; Ibarra, Jose; Rivera-Lugo, Richard
Subject: ACTION: FAQ repository for Public Distribution

TAs,

The action on this ticket is to determine if your divisions have generated any Q&As that aren't listed at the site below. If they aren't listed, we need to compile them and send them to OPA. If they are listed, then we don't have any actions.

I would think this applies to all the divisions. Can you provide me input by next Wednesday?

Thanks,

44/472

Brett

From: Case, Michael
Sent: Wednesday, April 06, 2011 10:34 AM
To: Sheron, Brian; RidsResOd Resource; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource
Cc: Rini, Brett; Coe, Doug; Correia, Richard; Gibson, Kathy; Richards, Stuart; Scott, Michael
Subject: RE: FOR TICKETING?? FW: FAQ repository in NRR

I think they already did. I checked a couple (Indian Point seismic and did the Japanese underestimate) and they are the answers that were in Annie's Q&A set.

From: Sheron, Brian
Sent: Wednesday, April 06, 2011 10:01 AM
To: RidsResOd Resource; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource
Cc: Rini, Brett; Case, Michael; Coe, Doug; Correia, Richard; Gibson, Kathy; Richards, Stuart; Scott, Michael
Subject: RE: FOR TICKETING?? FW: FAQ repository in NRR

Please ticket to Brett. Brett, please work with Divisions on this.

Mike, do we/can we post Annie's seismic FAQs on this site?

From: Flory, Shirley **On Behalf Of** RidsResOd Resource
Sent: Wednesday, April 06, 2011 9:18 AM
To: Sheron, Brian; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource
Subject: FOR TICKETING?? FW: FAQ repository in NRR

Brian: Should this be ticketed?

Thanks - Shirley

From: Muessle, Mary
Sent: Tuesday, April 05, 2011 6:47 PM
To: RidsNmssOd Resource; RidsResOd Resource; RidsFsmeOd Resource; RidsNroOd Resource; RidsNsirOd Resource
Cc: Schum, Constance; Pulliam, Timothy; Valentin, Andrea; Webber, Robert; Brenner, Eliot; Hayden, Elizabeth; Rothschild, Trip; Leeds, Eric; Nelson, Robert; Markley, Michael; Oesterle, Eric; Rihm, Roger; Ellmers, Glenn; Andersen, James; Landau, Mindy; Frazier, Alan; Sealing, Donna; Ficks, Ben; Holonich, Joseph; Bowman, Gregory; Rheaume, Cynthia
Subject: FAQ repository in NRR

As you may know, NRR has established a very comprehensive SharePoint site for Frequently Asked Questions regarding the Japan event. These questions were initially intended to be used internally so that all staff responding to questions from stakeholders could provide a consistent response and so that similar questions would not have to be researched several times over. The site is located at: <http://portal.nrc.gov/edo/nrr/dorl/japan/Shared%20Documents/Questions%20and%20Answers.aspx>

We would like to make this FAQ site available to the public as the primary consolidated site for all FAQs related to the event. To this end, I am asking your assistance by notifying us as to whether FAQs have been gathered in your office and would be appropriate for the public site. The FAQs should be sufficiently "high-level" so that they would typically be asked by a member of the public. We are not seeking very technical, detailed FAQs. They should also be FAQs that do not already appear on the SharePoint site. If your office has developed such FAQs, please send them to Beth Hayden, in OPA, who has agreed to review them to ensure they are appropriate for public release. You should then forward the OPA-approved FAQs to NRR (Eric Oesterle) for incorporation on to the SharePoint site.

Our goal is to make the site available over the course of the next week or so and then incorporate any additional OPA-vetted FAQs on to the site as soon as practicable.

Please let Mindy Landau or I know if you have any questions and thank you for your assistance and thank to NRR for this outstanding initiative!

Mary

Ibarra, Jose

From: Correia, Richard
Sent: Wednesday, April 13, 2011 8:17 AM
To: Ibarra, Jose
Cc: Coe, Doug
Subject: RE: ACTION: FAQ repository for Public Distribution

Thx Jose.

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Ibarra, Jose
Sent: Wednesday, April 13, 2011 7:55 AM
To: Correia, Richard
Subject: RE: ACTION: FAQ repository for Public Distribution

Rich,
I am working with John Kauffman on the Q&As that have been developed. Thanks. Jose

From: Correia, Richard
Sent: Tuesday, April 12, 2011 4:46 PM
To: Ibarra, Jose; Beasley, Benjamin; Ott, William; Coyne, Kevin; Demoss, Gary; Peters, Sean; Salley, MarkHenry
Cc: Coe, Doug
Subject: RE: ACTION: FAQ repository for Public Distribution

Jose,

Ben Beasley has spent a considerable amount of time for RES working with NRR and others on FAQs that were initiated from the EOC/Japan events. Please discuss with him what he has done and where the completed products are.

Thx

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Ibarra, Jose
Sent: Tuesday, April 12, 2011 1:35 PM
To: Beasley, Benjamin; Ott, William; Coyne, Kevin; Demoss, Gary; Peters, Sean; Salley, MarkHenry
Cc: Coe, Doug; Correia, Richard
Subject: FW: ACTION: FAQ repository for Public Distribution

BCs

YY/473

Have you developed Q&A for the Japanese Nuclear Event? See e-mail from Mary Muesle on a consolidated public Q&A list. I am not aware of any developed DRA Q&A list. I need the information by the end of the week. Thanks. Jose

From: Rini, Brett
Sent: Tuesday, April 12, 2011 11:40 AM
To: Ramirez, Annie; Ibarra, Jose; Rivera-Lugo, Richard
Subject: RE: ACTION: FAQ repository for Public Distribution

Followup to our TA meeting. Just a reminder.

From: Rini, Brett
Sent: Wednesday, April 06, 2011 6:01 PM
To: Ramirez, Annie; Ibarra, Jose; Rivera-Lugo, Richard
Subject: ACTION: FAQ repository for Public Distribution

TAs,

The action on this ticket is to determine if your divisions have generated any Q&As that aren't listed at the site below. If they aren't listed, we need to compile them and send them to OPA. If they are listed, then we don't have any actions.

I would think this applies to all the divisions. Can you provide me input by next Wednesday?

Thanks,
Brett

From: Case, Michael
Sent: Wednesday, April 06, 2011 10:34 AM
To: Sheron, Brian; RidsResOd Resource; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource
Cc: Rini, Brett; Coe, Doug; Correia, Richard; Gibson, Kathy; Richards, Stuart; Scott, Michael
Subject: RE: FOR TICKETING?? FW: FAQ repository in NRR

I think they already did. I checked a couple (Indian Point seismic and did the Japanese underestimate) and they are the answers that were in Annie's Q&A set.

From: Sheron, Brian
Sent: Wednesday, April 06, 2011 10:01 AM
To: RidsResOd Resource; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource
Cc: Rini, Brett; Case, Michael; Coe, Doug; Correia, Richard; Gibson, Kathy; Richards, Stuart; Scott, Michael
Subject: RE: FOR TICKETING?? FW: FAQ repository in NRR

Please ticket to Brett. Brett, please work with Divisions on this.

Mike, do we/can we post Annie's seismic FAQs on this site?

From: Flory, Shirley **On Behalf Of** RidsResOd Resource
Sent: Wednesday, April 06, 2011 9:18 AM
To: Sheron, Brian; Uhle, Jennifer; Valentin, Andrea; RidsResPmdaMail Resource
Subject: FOR TICKETING?? FW: FAQ repository in NRR

Brian: Should this be ticketed?

Thanks - Shirley

From: Muessle, Mary

Sent: Tuesday, April 05, 2011 6:47 PM

To: RidsNmssOd Resource; RidsResOd Resource; RidsFsmeOd Resource; RidsNroOd Resource; RidsNsirOd Resource

Cc: Schum, Constance; Pulliam, Timothy; Valentin, Andrea; Webber, Robert; Brenner, Eliot; Hayden, Elizabeth; Rothschild, Trip; Leeds, Eric; Nelson, Robert; Markley, Michael; Oesterle, Eric; Rihm, Roger; Ellmers, Glenn; Andersen, James; Landau, Mindy; Frazier, Alan; Sealing, Donna; Ficks, Ben; Holonich, Joseph; Bowman, Gregory; Rheaume, Cynthia

Subject: FAQ repository in NRR

As you may know, NRR has established a very comprehensive SharePoint site for Frequently Asked Questions regarding the Japan event. These questions were initially intended to be used internally so that all staff responding to questions from stakeholders could provide a consistent response and so that similar questions would not have to be researched several times over. The site is located at: <http://portal.nrc.gov/edo/nrr/dorl/japan/Shared%20Documents/Questions%20and%20Answers.aspx>

We would like to make this FAQ site available to the public as the primary consolidated site for all FAQs related to the event. To this end, I am asking your assistance by notifying us as to whether FAQs have been gathered in your office and would be appropriate for the public site. The FAQs should be sufficiently "high-level" so that they would typically be asked by a member of the public. We are not seeking very technical, detailed FAQs. They should also be FAQs that do not already appear on the SharePoint site. If your office has developed such FAQs, please send them to Beth Hayden, in OPA, who has agreed to review them to ensure they are appropriate for public release. You should then forward the OPA-approved FAQs to NRR (Eric Oesterle) for incorporation on to the SharePoint site.

Our goal is to make the site available over the course of the next week or so and then incorporate any additional OPA-vetted FAQs on to the site as soon as practicable.

Please let Mindy Landau or I know if you have any questions and thank you for your assistance and thank to NRR for this outstanding initiative!

Mary

Coe, Doug

From: Barnes, Valerie
Sent: Wednesday, April 13, 2011 6:36 PM
To: Coe, Doug
Cc: Correia, Richard
Subject: RE: HF bullets for long-term Fukushima-related research
Attachments: Revised HF input - Potential Long term Issues Rev1 rev nos.docx

Doug/Rich,

Sean, Dave Desaulniers and I met yesterday to go over the previous HFRB input and add thoughts Dave had, the WGHOFF discussed, and from additional email input I received from HFRB and NRR staff last week when I asked for thoughts to offer up to WGHOFF. I haven't had a chance to pass the new HF section past Sean and Dave, but am forwarding it to you anyway. Is there any reason I shouldn't share this draft with Dave?

I also did some other editing and added a few more thoughts to bullets in other sections.

Val

From: Coe, Doug
Sent: Wednesday, April 13, 2011 4:01 PM
To: Barnes, Valerie
Cc: Correia, Richard
Subject: RE: HF bullets for long-term Fukushima-related research

Not too late Val. There was already a list under HF, so I assume you will use that as a starting point. Pls send any additional to me/Rich.

From: Barnes, Valerie
Sent: Wednesday, April 13, 2011 3:25 PM
To: Coe, Doug
Subject: HF bullets for long-term Fukushima-related research

Doug,

I didn't get a chance last night to update the HF/HRA bullets. Is it too late to get them into what has gone/is going to Brian?

YY/474

Potential Long-term Issues & Research Areas as a Result of Japanese Earthquake/Tsunami and Impact on Nuclear Power Plants

Electrical Power / Station Black-out

- Assess plant response to long-term loss of onsite and offsite electrical power, as well as capabilities for mitigation (DE)
- Evaluate battery discharge duration when operated under light load (DE)
- Do we need to revisit the need for non-AC dependent hydrogen igniters on IC plants?
- Do we need AC-powered (with battery backup) hydrogen igniters in reactor buildings and/or in the vicinity of SFPs?
- Do plants have EDGs and their associated fuel tanks sufficiently protected from natural phenomena, especially floods?
- Assess the feasibility of licensees developing procedures to bring in portable electric generators to the site to a prepared location, and connecting the generators to the plant electric system. (DE)
- Assess the feasibility of developing procedures to bring in a 125 VDC battery bank and connect it to the plant DC system. (DE)
- Re-assess SBO capabilities at U.S. plants (DE)
- Should SBO coping strategies be seismically qualified to help mitigate beyond design basis seismic events where restoration of offsite power could be delayed beyond the coping time.

Instrumentation & Controls

- Do we have sufficient instrumentation in plants to accurately assess plant conditions following an accident, including severe accidents (e.g., water levels at various locations)? Is the instrumentation sufficiently robust to survive in the accident conditions?
- Is there additional instrumentation that would be of use to help manage a severe accident, such as hydrogen sensors, and would additional measures be necessary to ensure they are viable during a severe accident.
- Consider the need for additional severe accident monitoring instrumentation. Consideration should be given to providing for remote readings from the instrumentation at locations away from the unit. Wireless technology could potentially minimize the cost involved. (DE)
Wireless via satellite may provide greater reliability if land-based infrastructure is damaged. (DRA)
- Reassessment of instrumentation that can provide details on the progression of a severe accident; include remote monitoring of temperatures, pressures and radiation levels using high-capacity (long term) batteries (DE)
- Development of sensors that can be brought in by responders.

Reactor Pressure Vessel & Reactor Coolant System

- Performance issues of degraded/aged components: (DE)
 - Thermal loading: thermal shock, thermal transients
 - Pressure loading: explosive loadings, from thermal transients
- Components/Structures/Materials Performance in Severe or Beyond Design Basis Accidents: (DE)
 - Pumps/Valves
 - Seismic loading

- Weld Residual Stress Compendia: (DE)
 - Database of residual stresses of nuclear components: measurements & model results
- Materials research on the impact of lake/river/sea water used as makeup water to the reactor coolant system and SFP during an accident and impact on subsequent establishment of recirculation. (DE)

Containment

- PWR Containments do not have filtered vents. It is also not clear if they have vents that can be operated without AC power. Consider evaluating the benefits of putting a filtered vent on a PWR containment, along with vents that can be actuated without AC power (e.g. compressed air).
- reevaluate the need for filtered containment venting (DE)
- GSI-191 impact from seawater (DE)
- Assess coatings in the severe accident environment (DE)

Severe Accidents & Mitigation

- ~~Effectiveness of SAMGs and EDMGs provisions (including operator training, also including consideration of possible, scenario-related challenges, e.g., access limitations due to radiation or debris) (DRA)~~
- Develop SAMGs that include procedures for a containment breach (DE)
- Assess effects of high general radiation levels from a core melt on the ability for personnel to staff/man control rooms and implement SAMGs (DE)
- Assess the feasibility of two or more regional, licensee-managed/staffed TSCs/EOFs to coordinate severe accident response/mitigation, including assumption of command and control, if local events compromise the functioning of the affected licensee's TSC/EOF, and the communication/coordination infrastructure needed to support it (including satellite communications capabilities, as per I&C above, as well as communications among personnel). (DRA)
- Assess the need for additional regulatory guidance for severe accidents (DE)
- Review Severe Accident Management Guidelines/Emergency Operations Plans (DE)
 - Check core and spent fuel cooling procedures
 - Identify any materials issues with the cooling procedures (use of salt/river/processed "gray" water in an emergency)
- Do U.S. plants have the capability to inject ultimate heat sink water? How much time do plants with cooling ponds, like Palo Verde, have if they injected their ponds? Does that affect long term cooling strategies?
- Emergency H2 venting and whether current US plant configurations could lead to pockets of H2 in areas not covered by H2 igniters or recombiners, that give rise to explosive power sufficient to damage BWR secondary containments. (DRA) Adequacy and placement of hydrogen recombiners/igniters (DE)
- Are there accident management strategies in place for lower vessel flooding, and how well do we understand whether lower vessel flooding will work to retain a molten core inside the vessel?
- Fukushima 3 had several MOX fuel assemblies in it. How would a core with more or a full load of MOX assemblies affect the outcome of severe accidents?

Comment [v1]: OK to replace this with the first bullet/sub-bullets on SAMGs/EDMGs from the Human Factors section below, or just delete this one here, as it's covered in the HF section in more detail below.

Spent Fuel Pools / Independent Spent Fuel Storage Installations

- Is there a justifiable cost-benefit to off-loading from spent fuel pools all of the fuel that can be safely stored in dry casks? Removing all of the fuel that can be safely loaded in casks will not substantially reduce the heat load in the pool, but removing the fuel will increase the water volume in the pool. This will provide more time to boil off and uncover in an SBO. Also, spreading the fuel out in the pool will enhance cooling in the event of an uncover (e.g., no radiation heat source from adjacent assemblies) and may prevent or substantially delay melting.
- Develop a code which would consider the fuel loaded into a SFP, the location of the fuel within the SFP, the fuel burn-up and the decay time of each bundle, and then calculate whether exposure of the fuel to air would result in heat-up sufficient to result in fission product release to the environment. (DE)
- Assess the practicality of requiring a water makeup line to the SFP which would include a standpipe some distance remote from the plant power block. Assess the practicality of adding boron to this makeup source. (DE)
- Assess alternate means available for adding cooling water to spent fuel pools at all U.S. plants, including time frames, assuming loss of all electrical power (DE)
- Spent Fuel Pool accident phenomenology (similar to core damage accident research) and the effectiveness of B.5.b provisions (DRA)
- Spent fuel pool liner/cooling systems performance - degraded conditions & seismic (DE)
- Evaluate impact of using "dirty water" in spent fuel pools (DE)
- Are there natural phenomena that can damage dry casks? Dry casks are designed for earthquakes. Do we know how well they can withstand a beyond DBA earthquake? Performance of spent fuel pools and casks in BDBAs (DE)
- Reconsider the earliest timeframe in which fuel can be moved into dry storage, particularly for SFPs not at or below grade level. (DE)
- Revisit assessments of the response of SFPs and supporting structures to external pressure loads.
- Assess SFP design/configurations to identify any needs for enhanced personnel access to implement manual actions, in cases of building damage, high radiation, other severe conditions. (DRA)

Internal Events

- Assess (or reassess) the potential impact of a major hydrogen leak from the turbine-generator, or from the hydrogen cooling system, including the hydrogen storage tanks. (DE)
- Reassess the response of licensees to in-plant fires, particularly where successful response requires a number of manual actions in a relatively short period of time. If called upon on a mid-shift with no warning, do we have assurance that the required timeline could be met? (DE)

Earthquake / Tsunami

- Revisit the scope of on-going earthquake and tsunami research. (DE)
- Response to aftershocks following a design or beyond-design basis earthquake.
- How well can we predict tsunami wave height? Can scale model testing help improve models?
- Tsunami Study—The purpose of this study would be to use modern models and techniques to assess the tsunami hazard for existing sites including ISFIs, not otherwise assessed in new reactor reviews. The study would confirm that the tsunami hazard for facilities is either

appropriately considered in the licensing basis, is bounded by other natural events, or needs additional site specific bathymetric data. The study would also consider the need to validate the current NOAA model for tsunami, if necessary. (DE)

Other External Events

- Assess adequacy of current regulatory guidance for external events (DE)
- Are flooding measures, such as seals, inspected thoroughly and at an appropriate frequency based on their susceptibility to age-related degradation?
- Revisit natural disasters to confirm that plant licensing bases are still enveloped by the current science in the area. For example tornados, flooding from severe weather, etc. (DE)
- Revisit flooding from dams. Questions involving Oconee have already resulted in this area being revisited. Should we do more on dam failures and modeling the resulting flooding hazards? (DE)
- Are East and Gulf coast plants adequately protected from natural phenomena? There are reports that say that global warming is heating up the oceans, and this, in turn, spawns more violent hurricanes (e.g., Katrina). Have we conservatively estimated the storm surges associated with worst-case hurricanes that could hit the coasts, and are the plants along those coasts adequately protected from those storm surges and associated flooding?
- There are licensees on gulf and east coast sites (e.g., Waterford) that are or may be near other industrial facilities. How well are these facilities protected against extreme environmental events, and could failures (e.g. toxic gas release, explosions of flammable liquids and gases) at these facilities due to extreme environmental events render the control room at adjacent nuclear facilities uninhabitable?
- Revisit the impact of man-made disasters on plants. For example, plants located near industrial facilities such as petro-chemical. Do we remain confident that a major disaster at a nearby industrial facility will not have adverse impacts on the nuclear plant? If industrial processes at nearby facilities have changed since plant licensing, and have become more hazardous, how would we know? The impact of possible train or truck accidents involving hazardous materials is a related example. (DE)
- Assess potential vulnerabilities of sites to external events that may have extended effects on power, ultimate heat sink, and coping strategies (including B.5.b). Include realistic treatments of warning times.
- Assess the impact of possible combinations of man-made and natural external events. (DRA)

Plant Siting

- Should plant siting consider space between units to ensure that adequate space is provided for severe accident mitigation using external equipment, such as the Bechtel pumping rig.
- For multi-unit sites, licensees are only required to mitigate the security related event at one unit under B.5.b. As a result, there may only be one piece of critical equipment to serve two or more units. Furthermore, each unit may need to carry out several strategies, such as core and spent fuel pool so the equipment may only support one strategy at a time. The B.5.b equipment including the water sources are not seismically qualified. Are additional requirements warranted?

Dose Assessment

- The Fukushima event seemed to bring out shortcomings of our dose assessment codes, particularly RASCAL. Should we re-evaluate the need for improved, easy to use radiological dose assessment codes? Evaluate other issues related to radiation protection actions and health effects (DSA)
- Review of tools and information available for making evacuation recommendations, including assessment of impacts on population of the evacuation. (DE)
- Ground water contamination/transport. (DRA)

Risk Assessment

- Pursue Level III PRA (DRA)
- Common cause failure frequencies. (DRA)
- Re-examination of the concept of credible event to which a facility is designed, and a cost-benefit analysis to determine if designing to lower probability events than is currently the practice would increase safety at a reasonable cost. (DSA)
- Multi-unit site risk including spent fuel (wet and dry) and consequential (linked) multiple initiating events (e.g. seismic with induced tsunami and fire, plus damage to fire suppression and safety systems from either seismic or tsunami), i.e. a Level III PRA including human reliability aspects. (DRA)
- The Fukushima event highlights those events that are considered of relatively low probability, but potentially of high consequence; particularly events for which the uncertainties of occurrence and response are relatively large. One such area may be shutdown risk. Shutdown operations involve a wide variety of unusual conditions, to which operators are not often exposed due to high capacity factors and short refueling outages. Under electric deregulation, many licensees are now very focused on completing outages on schedule. This pressure may be felt by all levels of staff at the plant. In the past, the agency elected to allow the industry to address this area via industry initiatives under the umbrella of NEI. The NRC might elect to revisit this area based on the uncertainties and the voluntary nature of past actions to address this area. (DE)
- Assess potential benefits and costs of off-site storage centers for transportable emergency response equipment (as being required by the Swiss).
- Improved PRA real-time support of emergency management activities.
- Develop/enhance model(s) of human performance under extreme environmental conditions (e.g., heat, lack of illumination, presence of debris delaying response times). (DRA)

Human Factors

- Revisit SAMG and EDMG adequacy/implementation for different scenarios, to include
 - enhanced decision-making support if circumstances require adjusting goals (e.g., choosing among non-optimal options); I&C is degraded or unavailable;
 - procedures/PI&Ds and other technical documentation is degraded or unavailable;
 - off-site technical support is limited or unavailable, etc.
 - options for implementing required human actions if staffing is inadequate (e.g., the additional personnel needed can't reach the site) or available staff is unqualified for required tasks
 - re-evaluate the types and numbers/amounts of tools, equipment and PPE needed to implement manual tasks in challenging scenarios (e.g., working in high radiation; equipment for removing debris that is interfering with access; options for pre-staging; means of delivery, if pre-staged are unavailable; identification of alternatives to

"normal" tools and equipment if pre-staged are unavailable; training to ensure personnel know how to use them)

- enhanced personnel communications systems, such as satellite and wireless, to support communication among on-site personnel as well as with off-site resources
- re-visit operator training, as well as training needs for other types of personnel, including potential off-site responders, electrical distribution personnel (DRA)
- Risk and technical communication effectiveness (similar to DE's last bullet in the Incident Response/Coordination section below) – During the first several days of the event, U.S. government officials were not assisting the public to understand and interpret events in Japan as they occurred in real-time. Over that first weekend, a nuclear professional (check @arlight's timeline) stepped forward on twitter, and in subsequent media interviews, with accurate information about what appeared to be occurring and what it meant in terms of risk (based on his professional knowledge and the info provided by TEPCO and NISA). He was encouraged by NEI over the weekend, but then silenced by his employer on Monday. However, he offered an invaluable service to literally thousands of people worldwide over that first weekend. NEI, WNN, IAEA, UCS and others then began communicating information and answering questions on twitter, and WNN and IAEA both established facebook pages. Consider NRC's use of social media in possible future foreign or national events. As coordinated with other portions of the U.S. government, consider establishing a role for the NRC as the public resource for real-time technical and risk information regarding events at civilian nuclear facilities. (DRA)
- Evaluate the likely impacts of national cultures on the completeness and timeliness of communications to other regulators, other industry personnel and the public. Pursue opportunities to encourage international agreements on more effective information sharing.
- Re-visit B.5.b crediting for human actions, particularly in terms of a potential for too few trained staff available. (DRA)
 - Decisionmaking (DRA)
 - B.5.b Human Action credit—lowered staffing (DRA)
 - Prolonged Fatigue (DRA)
 - Human Action reliability (DRA)
- Re-visit the impact of safety culture on risk perception and expert judgment, on designers' decisions and on regulatory reviews of designs re: potential beyond-current-design basis conditions/events (i.e., Is there a need to recalibrate current, possibly unspoken/assumed values and views of "acceptable risk?") Safety Culture (DRA)
- Human perception of risk as incorporated into the design basis and regulations (DRA)
- Construction HRA (DRA)
 - Reexamination of design basis events (DRA)
 - Control room staffing and plant staffing for severe accidents (DRA)
 - Reliance on automation/overriding automation (DRA)
- Have we adequately considered the human factors aspects of a prolonged severe accident? In the Fukushima case, the event has been on-going for weeks-several-days, and it appears that the event will continue to require considerable licensee resources for some time. (DE/DRA)
 - In these circumstances, what are the most important sources of "stress" What level of stress does this put on the plant responders over time (e.g., fear, fatigue, concern for family members, inadequacies in the basics of food, shelter, exposure to extreme environmental conditions) and (DRA/DE)
 - How do these stressors affect individuals' their ability and willingness to carry out their duties, particularly over a prolonged period of time? (DRA/DE)

- For US licensees with a single nuclear unit, will they have the human resources to respond to a severe accident, which extends over weeks or months at a high intensity level? (DE) More broadly, will any U.S. site have the resources to support a prolonged response? (DRA)
- Are there ways to mitigate human factors issues, such as cooperative support agreements with other utilities with units of a similar design, commitments to care for affected family members, better pre-planning for food/shelter, etc.? (DE/DRA)
- How do these issues apply to NRC resident inspectors?
- Consider what pre-planned actions should be in place if plant staff are required to evacuate the plant. (DE)
- Update the technical/scientific bases of emergency preparedness assumptions about public responses to sheltering and evacuation recommendations, identify any improvements needed to enhance public compliance with recommendations, enhance communications. (DRA)

Incident Response / Coordination

- Emergency response given large area wide catastrophe and what can be expected (DRA)
- Assess onsite and offsite responder capabilities at U.S. plants (beyond B.5.b) (DE)
- Create organizational requirements and tools for reporting information during significant nuclear events internationally, perhaps as part of CNS or IAEA led effort. (DE)
- Assess NRC timing and procedures for manning NRC Ops Center in response to significant international events, perhaps using the INES scale for perspective on significance (DE)
- Assess NRC office procedures for supporting the NRC Ops Center in first few days of a crises, as well as for events of longer duration (DE)
- During the evolution of the accident at Fukushima, there was not a lot of coordination (at least initially) among various agencies (e.g., DOE and NRC). Concern was that everyone was advising the Japanese, with no coordination. In the event of another reactor accident outside of the U.S., should U.S. agencies have worked out plans for coordination beforehand? Does the international community need to coordinate better?
- It took a while before we called in industry and got an industry consortium going to interact directly with their Japanese counterparts (TEPCO). Should we encourage industry to create a standing consortium that would be poised to move in the event of another accident? Is this really a role for WANO?
- Revisit the roles, responsibilities and communications technologies available to resident inspectors in severe accident conditions as well as under conditions of large-scale infrastructure damage in the local area.
- Given overwhelming media interest, define the role of NRC in communicating general information on nuclear energy to the public even if incidents occur at foreign nuclear plants (DE)

Coe, Doug

From: Bowman, Eric
Sent: Thursday, April 14, 2011 7:51 AM
To: Frazier, Alan
Cc: Bowman, Gregory; Correia, Richard; Cheek, Michael; Collins, Timothy; Jones, Steve; Rosenberg, Stacey; Alexion, Thomas; McGinty, Tim; Blount, Tom; Ader, Charles; Scott, Michael; Gibson, Kathy; Tinkler, Charles; Coe, Doug; Helton, Donald; Armstrong, Kenneth; Layton, Michael; Wastler, Sandra; Brochman, Phil; Ordaz, Vonna; White, Bernard
Subject: REPLY: Background Information for April 29 SFP Briefing

Alan,

I had authored the memo documenting the evolution of the B.5.b requirements, ML092990438, but that more closely addresses her question 3 rather than her question 2. I'll be providing the portion of the April 29th briefing on the subject, addressing specifically her question 2 and I believe my slides be delivered prior to the briefing. The best short answer would be that the mitigative measures for SFPs are not per se requirements of the interim compensatory measures (ICM) Order, subsequent license conditions, and 10 CFR 50.54(hh)(2), which required development of mitigating strategies to maintain or restore SFP cooling without specifying what strategies/measures would suffice. The mitigating strategies that we found acceptable are listed in two source documents, the Phase 1 Guidance letter of February 25, 2005 (designated Safeguards information (SGI)), with an Official Use Only – Security Related Information (OUO-SRI) version provided in Section 3.0, Item B.2.m, of Appendix A of each licensee's safety evaluation (SE), and in NEI 06-12, Revision 2, Section 2, ML070090060. An example SE is the Calvert Cliffs one, available at ML071800461, with the pertinent portion on pages 7 and 8 of the pdf; Section 3.0 was a boilerplate used in all of the SEs.

Note that these measures are not applicable to decommissioning SFPs, which received a different ICM Order. My understanding is that these won't be addressed in the April 29th meeting.

The July 29, 2004 letter is at ML042030051, less the SGI attachment. I don't have a copy of that attachment, but it's content is captured in OUO – SRI form in the B.2.m portions of Appendix A, Section 3.0 of the SEs. I do have a copy of the SGI Phase 1 Guidance document.

Thanks!

Eric

From: Frazier, Alan
Sent: Wednesday, April 13, 2011 7:24 PM
To: Bowman, Eric
Cc: Bowman, Gregory
Subject: FW: FYI - Background Information for April 29 SFP Briefing

Eric,

Didn't you author a report on b5b that will Andrea's Q#2 below? Could you provide ML#(s) for b5b? Any other documentation you could point us to that would help answer questions 1 and 3 would be greatly appreciated as well.

Thanks

Alan L. Frazier
Executive Technical Assistant
Office of the Executive Director for Operations
U.S. Nuclear Regulatory Commission

301-415-1763

From: Kock, Andrea
Sent: Wednesday, April 13, 2011 6:42 PM
To: Frazier, Alan; Bowman, Gregory
Cc: Kock, Andrea
Subject: FW: FYI - Background Information for April 29 SFP Briefing

Alan/ Greg: I looked through all the lists of materials you sent. It looks like there are some helpful documents, but I'm not sure they will answer my basic questions because they are either too detailed or dated before the NAS 2006 report and orders following 09/11. What I would be interested in getting is:

- (1) A copy of a July 2004 letter to CNOs with suggested mitigation steps based on the 2006 NAS study
- (2) A listing of all mitigative measures required by b5b related to SFPs, (or if its easier a copy of the orders)
- (3) A summary or any other document which explains agency actions taken in response to the NAS study and in particular the NAS's recommendations for: emergency sprays, reorientation of fuel in the pools, additional cooling or access to power

Can you give me a call in the morning to discuss the best and least resource-intensive way to get this information. Perhaps I missed the items above in the listing you sent. If so, if you could point me to where to find this information in the documents you listed, that would be helpful.

Andrea Kock
United States Nuclear Regulatory Commission
Technical Assistant for Materials
Office of Commissioner Ostendorff
301-415-2896

From: Bowman, Gregory
Sent: Wednesday, April 13, 2011 1:50 PM
To: Bradford, Anna; Hipschman, Thomas; Marshall, Michael; Castleman, Patrick; Thoma, John; Davis, Roger; Snodderly, Michael; Orders, William; Tadesse, Rebecca; Franovich, Mike; Kock, Andrea
Cc: Frazier, Alan
Subject: FYI - Background Information for April 29 SFP Briefing

I attached a document put together by RES and NRR to prepare for the April 29 briefing on spent fuel pool safety. It provides a number of references, and we thought this might be of interest to all the offices. If you have any questions or would like any additional information, please let me know.

Greg

From: Crutchley, Julie
Sent: Wednesday, April 13, 2011 7:40 AM
To: Hasselberg, Rick; Crutchley, Mary Glenn
Subject: FW: FWD FYI: NEI Talking Points Comparing Chernobyl and Fukushima

FYI.

From: Hiland, Patrick
Sent: Wednesday, April 13, 2011 7:22 AM
To: NRR_DE Distribution
Subject: FW: FWD FYI: NEI Talking Points Comparing Chernobyl and Fukushima

FYI, if you recall the Chernobyl event and want to see a comparison to the ongoing event at Fukushima, the below info was generated by the Nuclear Energy Institute.

From: NEI Response Center
Sent: Tuesday, April 12, 2011 3:11 PM
Subject: NEI Talking Points Comparing Chernobyl and Fukushima



April 12, 2011

Talking Points **Comparing Chernobyl and Fukushima**

As the situation at the Fukushima Daiichi nuclear power plant continues, some are comparing events there to the 1986 accident at the Chernobyl reactor in the Soviet-era Ukraine. The Japanese government raised the crisis level from 5 to 7 on the International Nuclear and Radiological Event Scale, the same rating as the Chernobyl accident. Yet the accidents at the Chernobyl and Fukushima reactors are starkly different. Notably, the reactor designs are completely different; and to date, the public health consequences at Fukushima are much less severe.

Accident Conditions

- The Fukushima event has been rated 7 on the International Nuclear and Radiological Event Scale, the same level as the 1986 Chernobyl accident. Even so, Japanese authorities estimate that radiation released at Fukushima is only 10 percent of the amount released from the Ukrainian plant. A level 7 event, the highest on the rating scale, is considered a “major accident.” It applies to an event with “a major release of radioactive material with widespread health and environmental effects requiring implementation of planned and extended

4/14/11

countermeasures,” according to the International Atomic Energy Agency, which sponsors the ratings. The Japanese government set the rating, which it considers “provisional” and subject to change.

- Chernobyl was an old Soviet-design reactor, with less stable characteristics and no robust containment structures like most power reactors worldwide. Unconventional reactor operations at Chernobyl resulted in a runaway power surge followed by steam and hydrogen explosions and a sustained fire in the reactor. Absent a containment structure, the explosions propelled radioactive material from the reactor core high into the atmosphere and across eastern and western Europe for at least 10 days.
- The magnitude 9.0 earthquake and tsunami that struck the Fukushima Daiichi reactors were much stronger than the reactors were built to withstand. The resulting loss of on- and off-site electricity temporarily halted cooling of the fuel in the reactor cores and in the used fuel pools. There have been explosions at three of the reactors as a result of hydrogen buildup, but the reactor fuel remains inside the primary containment structures. Although some damage to the uranium fuel is expected, there have not been releases of radiation into the atmosphere at the levels seen during the Chernobyl accident.

Emergency Response

- The uncontrolled release of Chernobyl reactor’s fission products was exacerbated by the failure of Soviet authorities to take immediate action to protect surrounding populations. The most discernible health effect from Chernobyl—thyroid cancer in children—could have been mitigated by the early and widespread use of radiation protection procedures such as distribution of potassium iodide and control of the food supply in affected areas.
- By contrast, the Japanese authorities took early steps to evacuate people from a 12.5-mile zone around the Fukushima plant. Authorities also distributed potassium iodide to residents near the plant and restricted the transport and sale of milk (the main source of radioactive iodine intake), leafy vegetables and other food from the region. The Japanese government is monitoring and reporting radiation levels to citizens on an ongoing basis and is providing information and health protection instructions to the public.
- Besides child thyroid cancer, no other health effects have been detected in the populations around Chernobyl, according to a 2008 report of the United Nations Scientific Committee on the Effects of Atomic Radiation.
- Based on all information to date, no health effects are expected among the Japanese people as a result of the events at Fukushima.

Long-Term Health Effects

- The unique nature of the Chernobyl accident resulted in widespread airborne dispersion of radioactive cesium as fallout, which has a half-life of 30 years. The incident left the area in a 30 kilometer radius around the facility as a long-term restricted zone.
- Although measurements of radioactivity in the air and water near the Fukushima plant have been evident at varying levels, wide dispersion of radioactive materials has not occurred at the facility. While there may be localized spots that will require monitoring and remediation,

it is unlikely that any significant areas of land in Japan will have long-term restrictions.

Nuclear Energy Institute
1776 I Street NW, Suite 400
Washington, DC 20006
www.nei.org

P: 202.739.8000
F: 202.785.4019
Emergency Off-Hours: 703.644.8805

E: NEIResponseCenter@nei.org
Twitter: <http://twitter.com/neiupdates>

Click [here](#) to unsubscribe



From: Hiland, Patrick
To: Case, Michael
Cc: Skeen, David; Wilson, George; Correia, Richard; Coe, Doug; Beasley, Benjamin; Kauffman, John; Stutzke, Martin; Ake, Jon; Chokshi, Nilesh; Roquecruz, Carla; Ruland, William; Grobe, Jack
Subject: GI-199 support
Date: Wednesday, April 13, 2011 8:14:05 AM
Importance: High

Mike, first of all thanks to RES for the strong support over the past year regarding GI-199. I've relied heavily on all of the RES members from the GI-199 panel to communicate the analysis that was presented in the safety/risk assessment report. As indicated in my 9/2/2010 memo to RES, additional support from RES was to be obtained via a user need. I'm having my staff prepare a user need for both short-term and long-term support. Currently, we're planning a public meeting (work-shop) with industry the week of May 16 to discuss the development of a draft GL.

YY/476

REL

Coe, Doug

From: Dozier, Jerry
Sent: Wednesday, April 13, 2011 9:23 AM
To: Aissa, Mourad; Algama, Don; Alter, Peter; Armstrong, Kenneth; Bajorek, Stephen; Beasley, Benjamin; Blumberg, Mark; Caruso, Mark; Cheok, Michael; Coe, Doug; Coyne, Kevin; Dorn, Jaclyn; Dozier, Jerry; Drozd, Andrzej; Dube, Donald; Elkins, Scott; Esmaili, Hossein; Fuller, Edward; Gavrilas, Mirela; Ghosh, Tina; Gilmer, James; Harrison, Donnie; Hart, Michelle; Hasselberg, Rick; Helton, Donald; Howe, Andrew; Hudson, Nathanael; Kauffman, John; Kelly, Joseph; Koshy, Thomas; Krepel, Scott; Lane, John; Lee, Richard; Lee, Samson; Lien, Peter; Malliakos, Asimios; Marshall, Shawn; Mitman, Jeffrey; Mrowca, Lynn; Notafrancesco, Allen; Phan, Hanh; Rini, Brett; Rodriguez, Veronica; Rubin, MichaelB; Rubin, Stuart; Salay, Michael; Schaperow, Jason; Skarda, Raymond; Staudenmeier, Joseph; Thomas, Eric; Thurston, Carl; Tinkler, Charles; Velazquez-Lozada, Alexander; Wong, See-Meng; Yarsky, Peter; Zoulis, Antonios
Subject: Accident Analysts needed from April 17th to May 15th

Thank you very much for supporting the severe accident (SA) position in the operations support center. I am now trying to complete the watch bill for the severe accident position from April 17th to May 15th. Please note that the reactor safety team has been decreased to only the accident analyst and the BWR analyst. Therefore, you need to have served previously and be very comfortable working independently in the operations center.

Due to this new manning, I have been asked to fill the positions with analysts serving at least 4-5 consecutive shifts.

I have placed an excel spreadsheet at S:\HOCSAWatchbillvolunteers to provide you with the progress so far at filling the time slots. If you are available and would like to serve during this time period please place your name in the empty time slots of the accident analyst column corresponding to the shift that you would like to serve (Please fill in all of the colored spots in the consecutive sequence). Please do not erase any ones name (first come-first served) unless you have permission from them. Please close the Excel file when you are complete so that others may have access to the file. If you cannot serve on consecutive shifts...please let me know if you can be a substitute for a shorter duration.

Please make sure that your volunteering is during a time frame approved by your supervisor.

Again thank you very much for serving!

Jerry Dozier
Sr. Risk and Reliability Analyst
Division of Risk Assessment
Room 010D10 MS 010C15
(301) 415-3925
Jerry.Dozier@nrc.gov

44/477

Coe, Doug

From: Correia, Richard
Sent: Wednesday, April 13, 2011 1:10 PM
To: Coe, Doug; Beasley, Benjamin
Cc: Kauffman, John; Rini, Brett
Subject: RE: Additional Background Information on LOOP and SBO

Doug is correct...this falls under 10CFR50.13

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Coe, Doug
Sent: Wednesday, April 13, 2011 12:29 PM
To: Correia, Richard; Beasley, Benjamin
Cc: Kauffman, John; Rini, Brett
Subject: RE: Additional Background Information on LOOP and SBO

I would suggest removing our own reference to "EMP attack" in what we send forward. Threats of that nature are outside of our regulatory scope.

From: Correia, Richard
Sent: Wednesday, April 13, 2011 10:52 AM
To: Beasley, Benjamin; Coe, Doug
Cc: Kauffman, John; Rini, Brett
Subject: RE: Additional Background Information on LOOP and SBO

Thx Ben & John. I believe these issues are addressed in what RES has sent to the task force but I'll send it up to Brett since it does provide additional details the others suggestions did not.

Rich

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Beasley, Benjamin
Sent: Wednesday, April 13, 2011 10:08 AM
To: Correia, Richard; Coe, Doug
Cc: Kauffman, John
Subject: Additional Background Information on LOOP and SBO

Rich and Doug,

For your consideration...

YY/478

From: Kauffman, John
Sent: Tuesday, April 12, 2011 10:15 AM
To: Beasley, Benjamin
Subject: Draft e-mail

Ben,

I suggest we send something like the following to the Near-Term Task Force.

One of the areas the Near-Term Task Force is chartered to evaluate, based on the recent Fukushima Daiichi events, is Station Blackout.

In addition to improving NPP station blackout "coping times," we believe that minimizing the occurrence of extended duration losses of offsite power events (LOOP) (a necessary pre-condition to an extended station blackout), and enhancing the NPPs capabilities to cope with extended LOOPS are prudent. We base this conclusion on selected operating experience and information (provided below) that we have collected in the Generic Issues Program. The Operating Experience information below shows that LOOPS are typically precursor events (risk significant). Extended duration LOOPS can result from grid collapse or severe natural events such as hurricanes, ice storms, and tornadoes; in addition to earthquakes/flooding as occurred at Fukushima Daiichi. Although the NRC does not regulate the grid, the Generic Issues Program information shows that the U.S. grid is vulnerable to Electromagnetic Pulse (EMP) attack (act of war) and geomagnetic storms potentially causing lengthy, large loss of the grid events. There are other potential grid vulnerabilities such as cyber attack. Because there are numerous ways for extended LOOPS/SBOs to occur, it is important that their occurrence be minimized and that NPPs (reactors and spent fuel storage) can cope with such events if they do happen. We also note that the current SBO rule does not have update provisions. We would encourage that any revisions to the rule would have provisions to require licensees to maintain and periodically update their coping analyses.

Selected Operating Experience Documents on External Events

Effect of Hurricane Andrew on the Turkey Point Nuclear Generating Station from August 20 - 30, 1992
(extended LOOP) ADAMS ML063550235

Accident Sequence Precursor (ASP) Significant Precursors

[http://nrcweb.nrc.gov:8600/RES/projects/ASP/documents/Library/Significant%20Precursors/Significant%20Precursors%20\(Date\).pdf](http://nrcweb.nrc.gov:8600/RES/projects/ASP/documents/Library/Significant%20Precursors/Significant%20Precursors%20(Date).pdf) 4 Of 34 significant precursors involved LOOP, or partial LOOP (Items 2, 13, 21, and 28)

ASP LOOP Precursors (from FY2010 ASP SECY

<http://nrcweb.nrc.gov:8600/RES/projects/ASP/documents/Library/Past%20ASP%20SECY%20Papers/SECY-10-0125.pdf>) 25 LOOP ASP precursors between FY2001 and FY2009. Typically all LOOPS are ASP precursors.

IN 92-042, Failure of Electrical Power Equipment Due to Solar Magnetic Disturbances

<http://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/1990/in90042.html>

2003 Northeast Blackout <https://reports.energy.gov/BlackoutFinal-Web.pdf>

Generic Letter 2006-02 Grid Reliability and the Impact on Plant Risk and the Operability of Offsite Power

<http://www.nrc.gov/reading-rm/doc-collections/gen-comm/gen-letters/2006/gl200602.pdf>

Selected Information from Generic Issues Program activities

<http://www.narucmeetings.org/Presentations/NARUC%20EMP%20Presentation.pdf> (see page 8 for effects and page 13 for cost estimates)

EMP attack – potentially 70 to 90 % of U.S. population “unsustainable” (long term blackout, breakdown of transportation, water, energy infrastructure) Both EMP attack and electromagnetic storms can destroy large numbers of big transformers, which have limited manufacturing capacity and long-lead times (1-2 years) to replace.

100-year Solar Flare (Geomagnetic storm) – potential long term blackout affecting > 130 million people

Additional EMP information:

- Pre-GI-005 EMP Attack Threat <http://www.internal.nrc.gov/RES/projects/GIP/Pre-GenericsIssues.html>
- EMP Commission Report http://www.empcommission.org/docs/A2473-EMP_Commission-7MB.pdf

Additional solar flare information: http://science.nasa.gov/science-news/science-at-nasa/2009/21jan_severespaceweather/

The attached PDF file is the National Academy of Sciences “Severe Space Weather Events—Understanding Societal and Economic Impacts Workshop Report.”

Coe, Doug

From: Beasley, Benjamin
Sent: Wednesday, April 13, 2011 10:08 AM
To: Correia, Richard; Coe, Doug
Cc: Kauffman, John
Subject: Additional Background Information on LOOP and SBO
Attachments: 12507[1].pdf

Rich and Doug,

For your consideration...

From: Kauffman, John
Sent: Tuesday, April 12, 2011 10:15 AM
To: Beasley, Benjamin
Subject: Draft e-mail

Ben,

I suggest we send something like the following to the Near-Term Task Force.

One of the areas the Near-Term Task Force is chartered to evaluate, based on the recent Fukushima Daiichi events, is Station Blackout.

In addition to improving NPP station blackout "coping times," we believe that minimizing the occurrence of extended duration losses of offsite power events (LOOP) (a necessary pre-condition to an extended station blackout), and enhancing the NPPs capabilities to cope with extended LOOPS are prudent. We base this conclusion on selected operating experience and information (provided below) that we have collected in the Generic Issues Program. The Operating Experience information below shows that LOOPS are typically precursor events (risk significant). Extended duration LOOPS can result from grid collapse or severe natural events such as hurricanes, ice storms, and tornadoes; in addition to earthquakes/flooding as occurred at Fukushima Daiichi. Although the NRC does not regulate the grid, the Generic Issues Program information shows that the U.S. grid is vulnerable to Electromagnetic Pulse (EMP) attack (act of war) and geomagnetic storms potentially causing lengthy, large loss of the grid events. There are other potential grid vulnerabilities such as cyber attack. Because there are numerous ways for extended LOOPS/SBOs to occur, it is important that their occurrence be minimized and that NPPs (reactors and spent fuel storage) can cope with such events if they do happen. We also note that the current SBO rule does not have update provisions. We would encourage that any revisions to the rule would have provisions to require licensees to maintain and periodically update their coping analyses.

Selected Operating Experience Documents on External Events

Effect of Hurricane Andrew on the Turkey Point Nuclear Generating Station from August 20 - 30, 1992 (extended LOOP) ADAMS ML063550235

Accident Sequence Precursor (ASP) Significant Precursors

[http://nrcweb.nrc.gov:8600/RES/projects/ASP/documents/Library/Significant%20Precursors/Significant%20Precursors%20\(Date\).pdf](http://nrcweb.nrc.gov:8600/RES/projects/ASP/documents/Library/Significant%20Precursors/Significant%20Precursors%20(Date).pdf) 4 Of 34 significant precursors involved LOOP, or partial LOOP (Items 2, 13, 21, and 28)

ASP LOOP Precursors (from FY2010 ASP SECY

<http://nrcweb.nrc.gov:8600/RES/projects/ASP/documents/Library/Past%20ASP%20SECY%20Papers/SECY-10-0125.pdf>) 25 LOOP ASP precursors between FY2001 and FY2009. Typically all LOOPS are ASP precursors.

YX/479

IN 92-042, Failure of Electrical Power Equipment Due to Solar Magnetic Disturbances
<http://www.nrc.gov/reading-rm/doc-collections/gen-comm/info-notices/1990/in90042.html>

2003 Northeast Blackout <https://reports.energy.gov/BlackoutFinal-Web.pdf>
Generic Letter 2006-02 Grid Reliability and the Impact on Plant Risk and the Operability of Offsite Power
<http://www.nrc.gov/reading-rm/doc-collections/gen-comm/gen-letters/2006/gl200602.pdf>

Selected Information from Generic Issues Program activities

<http://www.narucmeetings.org/Presentations/NARUC%20EMP%20Presentation.pdf> (see page 8 for effects and page 13 for cost estimates)

EMP attack – potentially 70 to 90 % of U.S. population “unsustainable” (long term blackout, breakdown of transportation, water, energy infrastructure) Both EMP attack and electromagnetic storms can destroy large numbers of big transformers, which have limited manufacturing capacity and long-lead times (1-2 years) to replace.

100-year Solar Flare (Geomagnetic storm) – potential long term blackout affecting > 130 million people

Additional EMP information:

- Pre-GI-005 EMP Attack Threat <http://www.internal.nrc.gov/RES/projects/GIP/Pre-Genericlssues.html>
- EMP Commission Report http://www.empcommission.org/docs/A2473-EMP_Commission-7MB.pdf

Additional solar flare information: http://science.nasa.gov/science-news/science-at-nasa/2009/21jan_severespaceweather/

The attached PDF file is the National Academy of Sciences “Severe Space Weather Events—Understanding Societal and Economic Impacts Workshop Report.”



Severe Space Weather Events--Understanding Societal and Economic Impacts Workshop Report

Committee on the Societal and Economic Impacts of Severe Space Weather Events: A Workshop, National Research Council

ISBN: 0-309-12770-X, 131 pages, 8 1/2 x 11, (2008)

This free PDF was downloaded from:

<http://www.nap.edu/catalog/12507.html>

Visit the [National Academies Press](#) online, the authoritative source for all books from the [National Academy of Sciences](#), the [National Academy of Engineering](#), the [Institute of Medicine](#), and the [National Research Council](#):

- Download hundreds of free books in PDF
- Read thousands of books online, free
- Sign up to be notified when new books are published
- Purchase printed books
- Purchase PDFs
- Explore with our innovative research tools

Thank you for downloading this free PDF. If you have comments, questions or just want more information about the books published by the National Academies Press, you may contact our customer service department toll-free at 888-624-8373, [visit us online](#), or send an email to comments@nap.edu.

This free book plus thousands more books are available at <http://www.nap.edu>.

Copyright © National Academy of Sciences. Permission is granted for this material to be shared for noncommercial, educational purposes, provided that this notice appears on the reproduced materials, the Web address of the online, full authoritative version is retained, and copies are not altered. To disseminate otherwise or to republish requires written permission from the National Academies Press.

From: Coyne, Kevin
To: Correia, Richard
Subject: FW: Accident Analysts needed from April 17th to May 15th
Date: Wednesday, April 13, 2011 10:57:00 AM

Fyi...

By the way, Don Helton is going to take a pass unless the IRC calls him out by name.

From: Dozier, Jerry
Sent: Wednesday, April 13, 2011 9:23 AM
To: Aissa, Mourad; Algama, Don; Alter, Peter; Armstrong, Kenneth; Bajorek, Stephen; Beasley, Benjamin; Blumberg, Mark; Caruso, Mark; Cheok, Michael; Coe, Doug; Coyne, Kevin; Dorn, Jaclyn; Dozier, Jerry; Drozd, Andrzej; Dube, Donald; Elkins, Scott; Esmaili, Hossein; Fuller, Edward; Gavrilas, Mirela; Ghosh, Tina; Gilmer, James; Harrison, Donnie; Hart, Michelle; Hasselberg, Rick; Helton, Donald; Howe, Andrew; Hudson, Nathanael; Kauffman, John; Kelly, Joseph; Koshy, Thomas; Krepel, Scott; Lane, John; Lee, Richard; Lee, Samson; Lien, Peter; Malliakos, Asimios; Marshall, Shawn; Mitman, Jeffrey; Mrowca, Lynn; Notafrancesco, Allen; Phan, Hanh; Rini, Brett; Rodriguez, Veronica; Rubin, MichaelB; Rubin, Stuart; Salay, Michael; Schaperow, Jason; Skarda, Raymond; Staudenmeier, Joseph; Thomas, Eric; Thurston, Carl; Tinkler, Charles; Velazquez-Lozada, Alexander; Wong, See-Meng; Yarsky, Peter; Zoulis, Antonios
Subject: Accident Analysts needed from April 17th to May 15th

Thank you very much for supporting the severe accident (SA) position in the operations support center. I am now trying to complete the watch bill for the severe accident position from April 17th to May 15th. Please note that the reactor safety team has been decreased to only the accident analyst and the BWR analyst. Therefore, you need to have served previously and be very comfortable working independently in the operations center.

Due to this new manning, I have been asked to fill the positions with analysts serving at least 4-5 consecutive shifts.

I have placed an excel spreadsheet at S:\HOCSAWatchbillvolunteers to provide you with the progress so far at filling the time slots. If you are available and would like to serve during this time period please place your name in the empty time slots of the accident analyst column corresponding to the shift that you would like to serve (Please fill in all of the colored spots in the consecutive sequence). Please do not erase any ones name (first come-first served) unless you have permission from them. Please close the excel file when you are complete so that others may have access to the file. If you cannot serve on consecutive shifts...please let me know if you can be a substitute for a shorter duration.

Please make sure that your volunteering is during a time frame approved by your supervisor.

Again thank you very much for serving!

Jerry Dozier

44/480

Sr. Risk and Reliability Analyst
Division of Risk Assessment
Room 010D10 MS 010C15
(301) 415-3925
Jerry.Dozier@nrc.gov

From: Xing, Jing
To: Peters, Sean; Fieger, Stephen; Marble, Julie; D'Agostino, Amy; Morrow, Stephanie; Ki, DaBin; Lois, Erasmia; Cooper, Susan; Chang, James; Siu, Nathan; Barnes, Valerie; Coyne, Kevin; Demoss, Gary; Marksberry, Don; Desaulniers, David; Bongarra, James; Smith, John; Criscione, Lawrence; Boggi, Michael; Shoop, Undine; Keefe, Molly; Martin, Kamishan; Franklin, Carmen; Ghosh, Tina; Green, Brian; Hudson, Daniel; Ibarra, Jose
Cc: Coe, Doug; Correia, Richard
Subject: HFRB information-sharing Hour: Severe Accident Management and Dependencies - and Fukushima event

When: Wednesday, April 13, 2011 12:00 PM-1:00 PM (GMT-05:00) Eastern Time (US & Canada).
Where: HQ-CSB-04C17 (Church Street Building 4rd floor the small meeting room next to the kitchen)

Note: The GMT offset above does not reflect daylight saving time adjustments.

~~*~*~*~*~*~*~*~*

Hi folks,

The subject "HFRB information-sharing Hour" is actually the same as our HFRB FunHour, only I am not comfortable to use the word "fun" when the topic is related to Fukushima event.

Lately our staff have been having email discussions of US's practices of Severe Accident Management and Dependencies and the discussions were triggered and related to the Fukushima event. This HFRB information-sharing Hour is a platform for us to sit together and share what we know, learned, and think of this topic from PRA and HF perspectives.

Nobody is specifically assigned to lead the discussion, but our senior PRA and HF staff including Nathan, Susan, and Steve will provide valuable insights.

Please feel free to extend this invitation to other NRC staff who might be interested.

Here is the bridge line for dial-in:

Passcodes/Pin codes: 17150

Dial in numbers: 888-972-6405

See you there!

Jing

44 | 481

Coe, Doug

From: Correia, Richard
Sent: Wednesday, April 13, 2011 1:21 PM
To: Cheok, Michael; Ader, Charles; Scott, Michael; Gibson, Kathy; Tinkler, Charles; Coe, Doug; Coyne, Kevin; Helton, Donald; Armstrong, Kenneth; Collins, Timothy; Bowman, Eric; Jones, Steve; Layton, Michael; Wastler, Sandra; Brochman, Phil; Ordaz, Vonna; White, Bernard
Subject: FW: April 29 Meeting

All,

The latest on the April 29th Comm. Briefing.

Spent fuel pool discussions only.

ISFSIs later.

Slides sent up prior to the briefing.

I owe Greg Bowman the names of the presenters. What I got from yesterday's meeting was:

Steve Jones (Reg requirements for SFP)
Charlie Tinkler (post 9/11/01 studies)
Eric Bowman (post 9/11/01 additional requirements following the studies).

Please confirm or change this information.

Thanks all for the patience and understanding as we work thru this.

I'd also recommend we regroup one more time to review the final slides and work out any logistics if needed. How about next Tuesday or Wednesday?

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Bowman, Gregory
Sent: Wednesday, April 13, 2011 12:44 PM
To: Correia, Richard
Subject: RE: April 29 Meeting

Sending up the slides early is a very good idea. I'll let Snodderly know that we need to split the briefing – I'll let you know if I hear of any strong reactions from him, but I think he understands the challenge of doing all this in such a short period of time.

Also, I had just finished typing up an e-mail to you and Mike Cheok about another request we got... I'll send it and then maybe we can talk.

From: Correia, Richard
Sent: Wednesday, April 13, 2011 12:41 PM

TX/482

To: Bowman, Gregory
Subject: RE: April 29 Meeting

Greg,

The consensus is that we will brief Commissioners Apostolakis and Svinicki for 90 minutes on spent fuel pool safety/risk. We would ask that a separate briefing on ISFSIs be held at a later time.

I also thought it might be beneficial to the Commissioners if we sent up our presentations slides in advance to give them a sense of what we will be presenting and for them to perhaps formulate some questions in advance of the meeting. Thoughts?

thx

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Bowman, Gregory
Sent: Wednesday, April 13, 2011 7:06 AM
To: Correia, Richard
Subject: RE: April 29 Meeting

Okay. I know they don't want to push it back, so if you don't think you'll be able to cover it all in an hour and a half, it might be a good idea to try to spend an hour on wet storage (since that was his initial request and it's more topical, given Fukushima) and then spend 30 minutes on dry storage. If it turns out he needs more on dry storage, we can always see if one of the experts in NMSS can drop in with him to discuss it one on one.

From: Correia, Richard
Sent: Tuesday, April 12, 2011 5:14 PM
To: Bowman, Gregory
Subject: RE: April 29 Meeting

Thanks Greg for the quick response. Let me discuss with the other office reps and we'll get back to you asap.

Rich

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Bowman, Gregory
Sent: Tuesday, April 12, 2011 4:23 PM
To: Correia, Richard
Subject: April 29 Meeting

Rich,

I spoke with Commissioner Apostolakis's office. They've added 30 minutes to the end of the meeting to give you more time to cover all the material. Does that work for you? If not, it would probably be better to try to pare down the discussion than add more time. If it's looking like that's not possible, let me know and we can try to figure something else out.

I also asked about slides. Commissioner Apostolakis doesn't have any objections to the staff using slides. He's sensitive to the effort that's required to put slides together and he doesn't want the staff feel compelled to use them, so he's probably provided feedback in the past that he's okay just talking. I would recommend you do whatever works best – if that's slides, you should go ahead and use them.

If you need help with anything else, please let me know.

Greg

Coe, Doug

From: Correia, Richard
Sent: Wednesday, April 13, 2011 2:24 PM
To: Helton, Donald; Coyne, Kevin
Cc: Coe, Doug
Subject: FW: Request for SFP Information
Attachments: Followup Actions SFP Action Plan ML0037064120.pdf; NUREG_1353 Beyond DBA in SFPs _ML082330232.pdf

Don,

FYI... Steve recommends your table be supplemented with information below and from the attached.

Make sense?

Rich

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Jones, Steve
Sent: Wednesday, April 13, 2011 2:18 PM
To: Correia, Richard
Cc: Lee, Samson; Cheok, Michael; Collins, Timothy; Bowman, Eric
Subject: RE: Request for SFP Information

Rich,

I recommend adding the attached documents to the summary. The ADAMS accession numbers are in the file name.

NUREG-1353 described resolution of Generic Issue, 82, "Beyond Design Basis Accidents in Spent Fuel Pools," which was the first comprehensive evaluation of expanding requirements for fuel pool cooling. The followup actions paper on the SFP action plan describes voluntary measures implemented at many plants in the late 1990's to bring the plants closer to conformance with existing guidelines relative to spent fuel storage safety. These measures included adding level instrumentation, blocking potential siphon paths, managing potential coolant loss through the liner leak collection system, and establishing measures to power spent fuel pool cooling pumps from on-site power.

Thanks!

Steve

Steven R. Jones
Sr. Reactor Systems Engineer
NRR/DSS/SBPB
301-415-2712

44/483

From: Cheok, Michael
Sent: Wednesday, April 13, 2011 1:36 PM
To: Collins, Timothy; Bowman, Eric; Jones, Steve
Cc: Lee, Samson
Subject: FW: Request for SFP Information

FYI

From: Correia, Richard
Sent: Wednesday, April 13, 2011 1:29 PM
To: Bowman, Gregory; Cheok, Michael
Subject: RE: Request for SFP Information

Greg, Mike,

We just created the attached table on SFP studies. It contains a lot of information including document titles and ADAMS references. This should be a very good start.

Let us know if this is sufficient or if a sit down meeting is still preferred.

Rich

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Bowman, Gregory
Sent: Wednesday, April 13, 2011 12:45 PM
To: Correia, Richard; Cheok, Michael
Subject: Request for SFP Information

Rich and Mike,

We got a request from Andrea Kock in Commissioner Ostendorff's office. She's looking for some help finding background information on spent fuel pool safety, primarily to help her prepare for the April 29 meeting. She and her Commissioner strongly emphasized that they don't want the staff to write anything for them – Andrea is really just looking for someone who can point her to documents she can read to get prepared for the briefing. We'd most likely end up sending the same list to the other Commission offices, which in the end may help head off the need to conduct similar Commissioner briefings for the other offices.

Do you have someone who we can put Andrea in touch with? She tried to do this on her own, but had a lot of trouble finding things. It sounds like it wouldn't be large time commitment, maybe just a phone call or sit down with her, and then coming up with ML numbers for the background material she needs. If we can do it in person, which I think would be preferred, I can go along to make sure we're getting her what she needs and we're not taking on too much work.

Greg



UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

September 30, 1997

MEMORANDUM TO: Chairman Jackson
Commissioner Diaz
Commissioner Dicus
Commissioner McGaffigan

FROM: L. Joseph Callan *L. Joseph Callan*
Executive Director for Operations

SUBJECT: FOLLOWUP ACTIVITIES ON THE SPENT FUEL POOL ACTION PLAN

In a memorandum to the Commission dated July 26, 1996, the staff reported the findings from the Spent Fuel Pool (SFP) action plan. In that memorandum, the staff concluded that existing structures, systems and components related to the storage of irradiated fuel provide adequate protection for public health and safety. Concurrent with activities associated with the SFP action plan, the staff performed an independent review of all operating reactor licensees and found that each licensee was operating its spent fuel storage system in compliance with its operating license or would be before the next refueling outage. The results of this compliance review are documented in a memorandum to the Commission dated May 21, 1996. Notwithstanding these findings, the staff proposed to perform plant-specific evaluations or regulatory analyses to determine whether safety enhancement backfits could be justified at certain plants. The purpose of this memorandum is to report the results of the plant-specific evaluations and regulatory analyses performed for this study.

On February 28, 1997, the staff informed the Commission that our followup activities would also include a review of refueling cavity seals at certain plants. The addition of this review was the result of findings from the Office for Analysis and Evaluation of Operational Data (AEOD) study, "Assessment of Spent Fuel Pool Cooling," dated October 3, 1996.

The staff has completed the plant-specific evaluations and regulatory analyses for the eleven design issues identified in the staff's July 26 report and the memorandum to the Commission dated February 28, 1997. During our review, twelve licensees proposed certain voluntary actions to address the design issues identified in the staff's reports. A list of the licensees and their proposed actions is presented in Table 2 of the attached report. The staff will track the completion of these voluntary actions using the Commitment Tracking System.

CONTACT: Christopher Gratton, SPLB/DSSA/NRR
(301) 415-1055

In the July 26 report, the staff concluded that regulatory analyses should be performed for seven design issues to assess whether safety enhancements were warranted. The staff performed probabilistic screening analyses and found that, in most cases, event frequencies for sequences associated with these design issues were sufficiently low that further analyses were not warranted. In one instance where the probabilistic screening criteria was met, the staff performed a deterministic evaluation of the issue using plant-specific information and found that safety enhancements were not warranted. At LaSalle, the staff found unique design and operational features associated with the spent fuel pool cooling systems that require further analysis to determine whether safety enhancements are warranted. The staff concluded that, based on the results of these probabilistic evaluations and with the exception of the outstanding issues at LaSalle, safety enhancements at plants with these seven design issues could not be justified and no further actions will be taken. The staff also gathered and reviewed additional information about the four remaining design issues to determine the need for safety enhancements. Based on a review of this additional information, the staff determined that safety enhancements at these plants are not justified and that no further analysis is required. Details of the staff's evaluations for all issues can be found in the attached report.

Other actions identified in the staff's July 26 report to address spent fuel storage issues, which include rulemaking and revising staff guidance for SFP evaluations, are still under development. The staff has issued SECY-97-168, "Issuance for Public Comment of Proposed Rulemaking Package for Shutdown and Fuel Storage Pool Operation," requesting Commission approval to release for public comment the proposed rule on shutdown operations. Revision of the staff's SFP evaluation guidance documents will be completed by October 1998, as described in our response to the Staff Requirements Memorandum dated October 2, 1996.

Attachment: Report On Followup Actions From the Spent Fuel Storage Pool Action Plan

cc: SECY OGC OCA OPA CFO CIO

<u>DISTRIBUTION:</u>	PDR	FMiraglia	BBoger	Central Files
GHolahan	JZwolinski	EDO R/F	SNewberry	JStolz
HMiller, RI	LMarsh	JShea	LReyes, RII	GHubbard JRoe
WBeach, RIII	CGratton	EAdensam	EMerschhoff, RIV	CPaperiello
SStein	TCollins	LCallan	SPLB:R/F	JLieberman CHaughney
SCollins	CPoslusny	BSheron	JFlack	

DOCUMENT NAME: A:\COMPAPER.R6

*see previous concurrence

*SPLB:DSSA	*SPLB:DSSA	*SPLB:DSSA	SPSB:DSSA	D:DSSA	*TECH
CGratton:lk	GTHubbard	LBMarsh	*JFlack	*GMHolahan	EDITOR
9/05/97	9/05/97	9/09/97	9/10/97	9/11/97	9/5/97
ADT:NRR	DD:NRR	D:NRR	EDO <i>pk</i>		
*Sheron	*FMiraglia	*SCollins	LCallan		
9/12/97	9/16/97	9/16/97	9/17/97		

REPORT ON FOLLOWUP ACTIONS FROM
THE SPENT FUEL STORAGE POOL ACTION PLAN

1.0 BACKGROUND

The NRC staff developed and implemented a generic action plan for ensuring the safety of spent fuel storage pools in response to two separate postulated event sequences involving the spent fuel pools (SFPs) at two plants. The principal safety concerns addressed by the action plan involve the potential for a sustained loss of SFP cooling and the potential for a substantial loss of spent fuel coolant inventory that could expose irradiated fuel.

The first postulated event sequence was reported to the NRC staff in November 1992 by two engineers, who formerly worked under contract for the Pennsylvania Power and Light Company (PP&L). In the report, the engineers contended that the design of the Susquehanna station failed to meet regulatory requirements with respect to sustained loss of the cooling function to the SFP that could result from a loss-of-coolant accident (LOCA) or a loss of offsite power (LOOP). The heat and water vapor added to the reactor building atmosphere by subsequent SFP boiling could cause failure of accident mitigation or other safety equipment and an associated increase in the consequences of the initiating event. Using probabilistic and deterministic methods, the staff evaluated these issues as they related to Susquehanna and determined that public health and safety were adequately protected on the basis of existing design features and operating practices at Susquehanna. However, the staff also concluded that a broader evaluation of the potential for this type of event to occur at other facilities was justified.

The second postulated event sequence was based on an actual event that occurred at Dresden 1, which is permanently shutdown. This plant experienced containment flooding because of freeze damage to the service water system inside the containment building on January 25, 1994. Commonwealth Edison reported that the configuration of the spent fuel transfer system between the SFP and the containment similarly threatened SFP coolant inventory control. At Dresden Unit 1, portions of the spent fuel transfer system piping inside the containment could have burst due to freezing at an elevation that would drain the spent fuel coolant to a level below the top of stored irradiated fuel in the SFP. A substantial loss of SFP coolant inventory could lead to such consequences as high local radiation levels due to loss of shielding, unmonitored release of radiologically contaminated coolant, and inadequate cooling of stored fuel. The staff concluded that the potential for this type of event to occur at other facilities should be evaluated.

Finally, the action plan itself called for a review of events related to wet storage of irradiated fuel. From the review of events related to wet storage of irradiated fuel and information from the two postulated event sequences that prompted development of the action plan, the staff identified areas to evaluate for further regulatory action. Design information to support the SFP action plan's evaluation was developed through four onsite assessments, a

safety analysis report review for several operating reactors, and the staff's survey of refueling practices completed in May 1996.

Because the safety of fuel storage in the SFP is principally determined by coolant inventory, coolant temperature, and reactivity, the staff divided its evaluation into those areas. Coolant inventory affects the capability to cool the stored fuel, the degree of shielding provided for the operators, and the consequences of postulated fuel handling accidents. Coolant temperature affects operator performance during fuel handling, control of coolant chemistry and radionuclide concentration, generation of thermal stress within structures, and environmental conditions surrounding the SFP. SFPs are designed to maintain a substantial reactivity margin to criticality under all postulated storage conditions. In order for operators to promptly identify unsuitable fuel storage conditions, the spent fuel storage facility must have an appropriate means to notify operators of changes to the conditions in the SFP.

The report detailing the resolution of the SFP action plan was issued in a memorandum to the Commission dated July 26, 1996. Three courses of action were identified to address the concerns raised in the report: (1) plant-specific evaluations and regulatory analyses for safety enhancement backfits, (2) rulemaking, and (3) revision of staff guidance for SFP evaluation. Staff actions to address rulemaking and revision to guidance documents are still under development. The staff has issued SECY-97-168, "Issuance for Public Comment of Proposed Rulemaking Package for Shutdown and Fuel Storage Pool Operation," requesting Commission approval to release for public comment the proposed rule on shutdown operations. Revision of the staff's SFP evaluation guidance documents will be completed by October 1998, as described in our response to the Staff Requirements Memorandum dated October 2, 1996.

Concurrent with the SFP action plan, the staff conducted a compliance review of all licensees' spent fuel storage activities. The results were documented in a memorandum to the Commission dated May 21, 1996. At the time of the review, all plants were found to be in compliance with their licensing basis, or would be before their next refueling outage. The staff also concluded that SFP system design features and licensee operating practices were adequate in assuring protection for public health and safety. However, instances of incomplete or inaccurate documentation in licensee Final Safety Analysis Reports (FSAR) were identified. The staff is developing specific enforcement guidance to address these instances of non-compliance regarding licensees' FSARs.

On February 10, 1996, the Executive Director for Operations directed the Office for Analysis and Evaluation of Operational Data (AEOD) to perform an independent study of the likelihood and consequences of an extended loss of spent fuel pool cooling. The report included a review of the potential for and the consequences of SFP coolant inventory loss due to the failure of the refueling cavity seal. The results of the AEOD study were reported to the Commission in a memorandum dated October 3, 1996. Office of Nuclear Reactor Regulation (NRR) staff reviewed the results of the AEOD study and concluded that they were consistent with the findings of the SFP action plan. However, NRR decided to expand the scope of their SFP action plan followup activities

to include a new category for the review of refueling cavity seals. In a memorandum dated February 28, 1997, the staff informed the Commission that additional information regarding the refueling cavity seal designs at certain plants would be gathered to determine whether additional regulatory actions were warranted.

This report provides the results of the plant-specific evaluations and regulatory analyses performed for the 11 design features identified in the July 26 report and the staff's followup memorandum dated February 28, 1997. Overall, 48 of the 108 operating reactors have at least 1 of the following 11 design features of concern:

- (1) Absence of Passive Antisiphon Devices on Piping Extending Below the Top of the Stored Fuel
- (2) Transfer Tube(s) Within the SFP Rather Than a Separate Transfer Canal
- (3) Piping Entering the Pool Below the Top of the Stored Fuel
- (4) Limited Instrumentation for Loss-of-Coolant Events
- (5) Absence of Leak Detection Capability or Absence of Isolation Valves in Leakage Detection System Piping
- (6) Shared Systems and Structures at Multi-Unit Sites
- (7) Absence of Onsite Power Supply for Systems Capable of SFP Cooling
- (8) Limited SFP Decay Heat Removal Capability
- (9) Infrequently Used Backup SFP Cooling Systems
- (10) Limited Instrumentation for Loss-of-Cooling Events
- (11) Refueling Cavity Seals with Pneumatic Components

Table 1 contains a list of the categories evaluated for this followup activity, the type of evaluation performed (i.e., regulatory analysis or evaluation), the plants identified for each category, and the source document of the design concern (i.e., NRR SFP action plan or the AEOD study on SFP cooling).

2.0 STAFF'S REVIEW OF SFP ISSUES RESULTING FROM THE SPENT FUEL STORAGE ACTION PLAN AND THE AEOD STUDY OF SFP COOLING

The staff sent copies of the resolution of the spent fuel storage action plan to each of the plants identified in the July 26 report and offered these licensees an opportunity to address the issues related to their plants. Most of the licensees took the opportunity to respond to the request. Some licensees informed the staff that they have taken or plan to take voluntary actions that would eliminate the need to conduct the proposed regulatory

analysis. Other licensees provided additional information about the design and operation of their plant to address the issues. The staff considered all of the licensees' responses in its evaluation.

Review Methodology

The staff conducted a review for each category in the July 26 report and for the refueling cavity seal issue identified in the staff's memorandum to the Commission dated February 28, 1997. For each review, the staff either: (1) evaluated the licensees' voluntary actions as they applied to the design feature of concern for those licensees committing to voluntary actions, (2) performed a plant-specific screening analysis (probabilistic analysis) as a first step in the regulatory analysis process to determine whether safety enhancements could be justified, or (3) gathered additional information and evaluated the need for further regulatory analysis.

In each of the 11 categories identified for this study, the staff selected one or two plants as the lead plants for that category's review. The lead plant selection was based on plant design. For those plants undergoing regulatory analysis, the lead plant represented the most rigorous tests for the safety enhancement backfit. For those categories requiring further evaluation, plants with the "worst-case" example of the design feature of concern were selected for each category. Lead plants were also selected on the basis that their design features were representative of all plants in their category so that decisions based on the analysis of these lead plants could then be applied to all other plants in the category. If for some reason, a lead plant was eliminated from a category due to voluntary actions by the licensee or through a review of additional information, the next lead plant was selected on the same basis from the remaining plants in that category. If the results of the screening evaluation of a lead plant indicated the need for further regulatory action, additional plants in that category would also be screened.

Plants Taking Voluntary Actions

In response to the staff's July 26 report on the resolution of the SFP action plan, several licensees informed the staff that they intended to perform certain voluntary actions to address the issues identified for their plants (See Table 2). The staff reviewed the proposed actions by the licensees and determined whether the actions addressed the design features of concern. In some cases, the proposed actions by licensees eliminated the need for further regulatory actions for certain categories. The staff will track the licensee's voluntary actions using the Commitment Tracking System to ensure the underlying issue is resolved in a timely manner.

Plant-Specific Regulatory Analysis

The staff's July 26 report concluded that plant-specific regulatory analysis should be performed for seven categories of design issues to determine whether a safety enhancement backfit was warranted. For these categories, a probabilistic analysis was performed as a screening criteria to determine the likelihood of attaining certain predesignated endstates. The staff visited seven plants, the lead plants for 5 of the 7 regulatory analysis categories,

to gather plant-specific design and operational information to be used in the probabilistic analyses. For the other two regulatory analysis categories, one issue was resolved solely through voluntary actions by the licensees and the other issue was resolved by performing a probabilistic analysis using information already available to the staff.

Regulatory analyses were performed by first conducting a screening analysis using plant-specific design and operational information. Two endstates were chosen to test the design features under evaluation. For inventory control analyses, an endstate corresponding to a SFP level one foot above the top of the SFP rack was used. For issues related to SFP boiling, an endstate corresponding to sustained boiling in the SFP for greater than 8 hours was used. These endstates chosen for this evaluation represent conservative points in the event sequences where public health and safety was assured (i.e., several magnitudes above the point of exposing fuel or causing a safety system degradation). The endstates were also chosen to be consistent with previous models used by the staff to evaluate SFP events (see the staff's safety evaluation of SFP issues at the Susquehanna plant, dated June 19, 1995).

The staff used probabilistic analyses to determine the frequency of these endstates for the lead plants in each category. An endstate frequency greater than 1×10^{-5} /yr indicated the need to perform further analysis of the design feature, including sensitivity analyses, value-impact analyses, or a deterministic evaluation of the plant's response to the event sequence. An endstate frequency less than 1×10^{-6} /yr indicated that the probability of the event occurring was low and that a safety enhancement could not be justified. For endstates in the range between 10^{-6} /yr and 10^{-5} /yr, engineering judgement based on the margin available was used to determine whether further analysis was necessary.

Plants Requiring Further Evaluation

As a result of the staff's July 26 report and the review of the AEOD study of SFP cooling, the staff identified four categories where further evaluation of certain design features was required to determine whether additional regulatory action was warranted. For the plants in these categories, the staff gathered plant-specific information from the licensees through site visits, information requests, telephone conferences, and by reviewing archived information at the NRC. On the basis of these reviews, the staff made case-by-case determinations regarding the need for further regulatory action.

3.0 RESULTS

3.1 Inventory Control Issues

3.1.1 Absence of Passive Antisiphon Devices on Piping Extending Below the Top of the Stored Fuel

SFPs at four plants (Turkey Point 3 and 4, Robinson, and Davis-Besse) lacked antisiphon devices for piping that could, through improper operation of the system, reduce coolant inventory to a level that provides insufficient

shielding and eventually expose the stored fuel. In all cases, the piping is a drain path from the lower portion of the SFP that is no longer used by the licensees. Licensees provide protection against a siphoning event by providing locked-closed valves, providing a low-level alarm, and establishing operator actions to stop the siphon flow and add makeup water. The staff believed that a design modification to introduce passive antisiphon protection for the SFP could be easily implemented at the plants currently lacking this protection. The staff planned to perform a regulatory analysis to determine whether such design modifications could be justified.

The licensees in this category took the opportunity to address this issue in their responses to the NRC. Each licensee provided similar testimony as to why a loss-of-inventory event through this piping should be considered a low likelihood event. The piping at each plant is seismically qualified up to the first isolation valve and exposed to a benign environment and the isolation valve in the piping is normally locked closed and not included in any plant operating procedures. In addition, at the plants reviewed for this category, the lower suction piping connects to the normal suction line for the SFP cooling system which terminates six to twenty feet above the top of the spent fuel racks providing siphon protection if a siphon event occurred. The upper isolation valve on the normal suction line would also have to be mispositioned to threaten the stored fuel, further reducing the probability of a siphon event occurring.

Regardless, the licensees in this category informed the staff that they are making voluntary modifications to their plants to further reduce the likelihood of an inadvertent inventory loss. The modifications to the SFP cooling systems include removing the valve and blanking the pipe or permanently locking closed and removing the valve operator from the piping of concerns. Other controls, for example, tagging the locking devices to alert operators to their significance, are planned to prevent operators from misaligning the valves.

On the basis of these voluntary actions, further regulatory actions are not warranted. The staff will continue to follow the progress of the voluntary actions for the licensees in this category until they are completed.

3.1.2 Transfer Tube(s) Within the SFP Rather Than a Separate Transfer Canal

Transfer tubes are normally open during refueling operations. When these openings are below the top of the stored fuel without a passive design feature to ensure adequate coverage of the stored fuel (e.g., a weir located between the transfer tube and the stored fuel), any drain path from the refueling cavity has the potential to reduce coolant inventory in the SFP to an extent that the stored fuel could be exposed to air. Licensees with SFPs that do not have these passive design features currently provide protection against loss-of-inventory events in the SFP from leakage in the refueling cavity through level alarms, closure of the fuel transfer tube blank flange during reactor operations, and operator actions to isolate the leakage and add makeup water. During the staff's review, which was conducted as part of the SFP action plan, the staff concluded that the relative rarity of a fuel transfer system lacking passive design features to prevent the uncovering of the stored fuel warranted a

more detailed review of the system design and the administrative controls at these plants. The staff performed a probabilistic analysis of this issue to determine whether further regulatory analysis would be needed.

SFP designs at five plants (Oconee 1, 2, 3, Crystal River 3, and Maine Yankee) have fuel transfer tubes that enter directly into the pool below the level of the stored fuel with no passive design feature to separate the fuel transfer tube from the stored fuel. Of the five plants, the staff chose to perform this assessment at Oconee because the single SFP that services Units 1 and 2 has four fuel transfer tubes, increasing the frequency of operations with the transfer tube open and maximizing the flow rate out of the pool through the tubes should a large leak or other coolant diversion event occur somewhere in the refueling cavity or the reactor vessel. The staff considered the design of this spent fuel storage system to be a "worst case" compared with the other plants in this category.

The staff conducted a site visit to Oconee to collect plant-specific information regarding the design of the Units 1 and 2 SFP and refueling cavities. This information was used to develop a plant-specific probabilistic analysis to determine the extent to which the Oconee plant design affected the potential for a loss-of-coolant inventory event. The staff considered normal and refueling system configurations in its assessment and estimates for the likelihood for relevant pipe breaks, seismic events, and operator errors.

The staff's assessment found that even with four fuel transfer tubes penetrating directly into the SFP below the level of the stored fuel, because of the minimal amount of piping available to fail and the availability of the transfer tube isolation valve to isolate leaks, the frequency of events resulting in the uncovering of the fuel was estimated to be less than $1 \times 10^{-6}/\text{yr}$. The probabilistic analysis quantified the frequency of each sequence that led to the endstate resulting in SFP coolant one foot above the top of stored fuel. As a result of the low likelihood that the fuel could be uncovered, the staff considers this design feature to be of relatively low risk-significance. On the basis of this finding, no further regulatory action will be taken on this issue for any of the plants in this category.

3.1.3 Piping Entering the Pool Below the Top of the Stored Fuel

In addition to having transfer tubes that enter directly into the SFP, the three units at Oconee have an interfacing system, a portion of the standby shutdown facility (SSF), that connects to the transfer tube. The normal alignment of the transfer tube during reactor operations is to have the transfer tube isolation valve open to allow the interfacing system to draw water from the SFP under emergency conditions (a blank flange is installed on the transfer tube to maintain containment integrity and to prevent leakage from the SFP). This fuel transfer tube arrangement is unique to Oconee. Pipe breaks or misalignment of the valves supporting the SSF has the potential to drain coolant from the SFP to such an extent that fuel could be exposed to air. The licensee provides protection against events involving this piping through seismic qualification requirements, design features such as a normally closed valve on each SSF line, direct level indication in the SFP, and training operators to take appropriate actions (e.g., isolate the leakage and

add makeup water). However, the staff concluded that a safety enhancement modification involving this piping or other spent fuel storage systems may be justified to ensure adequate protection of the stored fuel. A probabilistic analysis of this issue was performed to determine whether further regulatory analysis would be needed.

In the assessment described in Section 3.1.2 of this report, the staff considered the reactor coolant makeup piping that is part of Oconee's SSF. That assessment led the staff to conclude that the piping penetrating the SFP below the stored fuel is of low risk significance. The staff found that loss-of-coolant-inventory events involving the fuel transfer tube and interfacing piping that result in a SFP level one foot above the top of the fuel storage racks had a frequency of less than $1 \times 10^{-6}/\text{yr}$.

Therefore, as a result of this estimate of the low likelihood of a significant coolant inventory loss in the SFP due to this design feature and consistent with the findings of Section 3.1.2 of this report, the staff considers that further regulatory actions are not warranted.

3.1.4 Limited Instrumentation for Loss-of-Coolant Events

Some facilities have limited instrumentation to reliably alert operators to a loss-of-SFP coolant inventory. Direct SFP level instrumentation is not available to operators at certain plants as an indication of a loss-of-coolant event. Operators use related alarms (e.g., a loss-of-SFP cooling alarm or an alarm for low levels in the SFP cooling surge tanks), operating procedures, and direct observation to provide protection against loss-of-coolant events. The staff performed a probabilistic analysis of this issue to determine whether any safety enhancement backfits to improve the SFP level monitoring capability could be justified under the current guidance.

Seven plants (Big Rock Point, Dresden 2 and 3, Peach Bottom 2 and 3, and Hatch 1 and 2) do not have direct level indication in their SFPs. In response to the staff's task action plan, four of the seven plants are taking voluntary actions to address this issue. At Peach Bottom 2 and 3, the licensee is installing level switches in the SFP that will provide low level alarms locally and in the control room. At Dresden 2 and 3, the licensee is adding administrative controls to site procedures to locally monitor pool level during periods when forced cooling is secured or when AC power is lost. With the SFP cooling system operable at Dresden, level in the SFP can be monitored using the alarms associated with the SFP cooling system.

The staff selected four plants, Hatch 1 and 2 and Dresden 2 and 3, to evaluate whether limited level instrument affected the safe storage of spent fuel. The staff made site visits to these plants to gather plant-specific design information to be used in the probabilistic analysis. Hatch and Dresden were selected because they were representative of all plants in this category. Due to the design of the SFP and associated cooling systems of the plants in this category, conclusions based on the analyses performed for the Hatch and Dresden plants were considered to be applicable to all plants in this

category. The staff performed a probabilistic analysis of event sequences dependent on SFP level indication to determine whether a safety enhancement backfit could be justified.

The staff found that for the four plants modeled for this analysis, the total endstate frequency for all sequences resulting in a SFP level one foot above of the top of the spent fuel racks was less than $1 \times 10^{-6}/\text{yr}$. The analysis took loss-of-cooling sequences without makeup water into consideration, as well as pipe breaks and flow diversions. This low frequency indicates that additional analysis concerning direct SFP level indication would not be cost beneficial. Therefore, the staff will not pursue further regulatory action on this issue for any plants in this category.

3.1.5 Absence of Leak Detection Capability or Absence of Isolation Valves in Leakage Detection System Piping

Coolant inventory loss is not easily isolated following events that breach the SFP liner at facilities that do not provide a method of isolating the liner leakoff system. The limited flow area through leak detection system telltale drains, the low leak rate through the seismically designed concrete structure, controls on movement of heavy loads over the fuel pool, and operator actions (to plug leak detection system drains and add makeup) provide protection at these plants. The staff noted in its report on the resolution of the SFP task action plan that insufficient information was available at the time of the review to evaluate the makeup capability relative to credible leakage through the SFP liner.

Five plants were identified as having an SFP liner leakoff system that lacks a method for isolating a leak (Salem 1 and 2, DC Cook 1 and 2), or as having a liner that does not include a leakoff system (Indian Point 2). Two additional plants (Zion 1 and 2) that do not have liner leakoff isolation capability were identified after the publication of the July 26 report on the resolution of the SFP action plan. A review of the design information for each plant regarding credible leakage and makeup capability was performed by the staff to confirm that this issue had been addressed for these plants. The staff found that for all plants in this category, licensees have performed the necessary evaluations to ensure the available makeup rate to the SFP exceeds the leakage rate for credible leakage scenarios.

On the basis of this assessment, the staff has determined that no further regulatory action is warranted on this issue for any plants in this category.

3.1.6 SFP Loss of Inventory Through Failure of the Refueling Cavity Seal

During refueling operations, refueling cavity seals form a watertight boundary between the reactor vessel and the refueling cavity. The seal is established and the refueling cavity is flooded so that the spent fuel can be transported safely from the reactor vessel to the SFP. Failure of this seal during refueling operations could dramatically lower the inventory level in the SFP.

The staff focused this review on boiling-water reactors (BWRs) with refueling cavity seals that contain pneumatic components. The staff selected BWRs

because the refueling cavity is isolated from the SFP through the use of a gate that must be put in place with a building crane. Conversely, pressurized-water reactors transport spent fuel from the refueling cavity to the SFP through a transfer tube that contains a valve that can be closed in the event of a leak. Sudden gross leakage at a BWR, though unlikely, would be difficult to isolate before a significant level decrease would occur in the SFP. In addition, because pneumatic seals must have reliable air supplies to keep the seal from deflating and leaking, it is more likely that a significant leak would occur at plants that have pneumatic seals compared to plants with mechanical seals.

Of the five BWRs with pneumatic refueling cavity seals, three plants (Limerick 1 and 2 and Nine Mile Point 2) were selected for this evaluation. The staff reviewed previous licensing information to determine whether these seals were susceptible to gross leakage or failure that could threaten stored fuel indicating the need for further regulatory actions. Our review focussed on the design of the seal rather than its installation and testing because the seal must be installed and the cavity flooded to the level of the SFP before the refueling cavity is aligned with the SFP. This substantially reduces the risk of a seal failure that has been installed or tested incorrectly affecting the safety of the stored fuel. The cavity seals at the remaining two plants (Susquehanna 1 and 2) were extensively reviewed and accepted by the staff as documented in NUREG/CR-4525, "Closeout of IE Bulletin 84-03: Refueling Cavity Water Seal," dated June 1990, and are similar in design to the seals installed at Limerick 1 and 2.

In response to a refueling cavity seal event at Haddam Neck in 1984, the staff issued Office of Inspection and Enforcement Bulletin (IEB) 84-03, "Refueling Cavity Water Seal." Licensees were required to evaluate the potential for a failure of a refueling cavity seal and provide a summary report to the NRC. IE Information Notice 84-93, "Potential for Loss of Water From the Refueling Cavity," was issued late in 1984 to highlight events in which two failures of pneumatic seals had the potential to drain the refueling cavity. A temporary instruction was also developed in late 1984 to provide guidance for performing reviews and inspections regarding utility responses to IEB 84-03.

The staff issued the findings from IEB 84-03 in NUREG/CR-4525 (June 1990). The study found that the Limerick 1 and 2 refueling cavity seal design uses two pneumatic seals, with keepers (to prevent seal displacement even with a loss of air pressure), one located above the other, in a narrow, fixed outer annulus. The outer annulus is covered with a plate fitted with compressible seals at each edge. The inner seal is a mechanical expandable bellows. Air supplies to the pneumatic seals are redundant. The seals include a leak detection system to alert operators to leakage past the pneumatic components.

Nine Mile Point 2 uses a Presray wedge-type refueling cavity seal design located in a narrow, fixed annular opening. The seal design includes flanges that rest on the edges of the support plates. The annular opening is maintained at a fixed distance to provide interference if the seal becomes dislodged. The corners of the support plates are chamfered at the same angle as the seal so that a wedge effect occurs, becoming tighter as the water pressure above the seal increases. The annulus within which the seal fits

extends the full length of the seal thereby preventing the ballooning and hinging of the seal seen at Haddam Neck.

After reviewing the plant designs and supporting documentation submitted by the licensees in response to IEB 84-03, the NRC concluded that the licensees for Limerick 1 and 2 and Nine Mile Point 2 complied with the actions required by the bulletin. The report also came to the following conclusions:

- (1) The two major cavity seal leak events at Haddam Neck and Surry 1 were due to design and testing deficiencies unique to each plant.
- (2) Most applications of pneumatic seals incorporate the Presray design (e.g., those at Nine Mile Point 2), which uses a solid wedge portion as the primary seal and the inflated portion as the backup seal. The inflated portion acts as the initial sealing mechanism until sufficient head builds up to seal the solid wedge. The success of this design has been adequately demonstrated.
- (3) In the few plants with pneumatic seals that do not use the solid wedge design (e.g., Limerick 1 and 2), some other backup means is provided that is obviously adequate or has been tested. For Limerick, this includes a stainless steel coverplate with compressible seals at each edge that covers the refueling cavity seal outer annulus. The coverplate acts to reduce leakage flow through the outer annulus in the unlikely event of a pneumatic seal failure.

In a separate study, the staff issued a generic evaluation of failures of refueling cavity and transfer gate pneumatic seals in NUREG-1353, "Regulatory Analysis for the Resolution of Generic Issue 82, 'Beyond Design Basis Accidents in Spent Fuel Pools,'" dated April 1989. The staff concluded that on the basis of the heightened awareness of refueling cavity seal design, installation, testing and maintenance; of the need for adequate procedures to address seal failures as identified in IEB 84-03; and considering that there is sufficient time available to diagnose a serious seal failure, the best estimate frequency is 3×10^{-8} /reactor-yr of a seal failure resulting in spent fuel damage.

On the basis of the staff's conclusions in NUREG/CR-4525 concerning the acceptability of Nine Mile Point 2 and Limerick 1 and 2 refueling cavity seal designs, this review, and the low probability of a seal failure resulting in spent fuel damage as documented in NUREG-1353, the staff concludes that no further regulatory action is required for the plants in this category.

3.2 Decay Heat Removal Reliability Issues

3.2.1 Shared Systems and Structures at Multi-Unit Sites

At certain multi-unit sites, with one unit being refueled, the decay heat rate in the SFP may be sufficiently high that the pool could reach boiling in a short time following a loss-of-cooling event. Communication between the fuel pool area and areas housing safety equipment supporting the operating unit through shared ventilation systems or shared structures may cause failure or

degradation of those systems. Restrictive administrative controls on refueling operations, reliable SFP cooling systems, and operator actions to restore forced cooling and protect essential systems from the adverse environmental conditions that may develop during SFP boiling provide protection at these plants.

The staff identified 13 plants at which SFP boiling may affect safety equipment in an adjoining unit through shared systems and structures. The staff reviewed the configuration of each plant in this category and performed a regulatory analysis of three plants (Hatch 1 and Dresden 2 and 3. Hatch 2 is not included in this category because safety equipment required for the safe shutdown of Unit 2 is not affected by boiling of either Unit 1 or 2 SFPs). These plants were selected because they were representative of all 13 plants in this category. The staff conducted site visits to Hatch and Dresden to gather plant-specific information about the design and operation of the spent fuel storage pool and cooling system. This information was used to perform the probabilistic analysis of the event sequences relevant to this design feature.

To assess the effects of SFP boiling on safety equipment at these plants, an estimation of the frequency of sustained pool boiling event was calculated. The staff calculated the frequency of the endstates (i.e., sustained SFP boiling for a minimum of 8 hours, with or without makeup to the SFP) that would have the capability of producing sufficient heat and water vapor to degrade the operating units' safety equipment. The endstates were chosen at points in the event sequences where public health and safety were assured. The staff calculated the frequency for these event sequences as a screening measure for this analysis. A sustained boiling frequency of approximately $10^{-6}/\text{yr}$ was the basis to decide whether to perform further analyses. Sustained boiling frequencies of greater than $1 \times 10^{-5}/\text{yr}$ indicate the need to perform further analyses. However, sustained boiling frequencies of $1 \times 10^{-6}/\text{yr}$ or less indicate that the frequency of these events is sufficiently low that even the lowest cost safety enhancements could not be justified. The staff used engineering judgement to determine whether further analysis was necessary for those sites where the sustained boiling frequency was calculated to be between $10^{-6}/\text{yr}$ and $10^{-5}/\text{yr}$. Initiating event sequences that were considered in this evaluation included the loss-of-SFP cooling system, seismic events, and loss of offsite power.

The results of the evaluation indicated that there is a low likelihood of events that result in sustained boiling for Dresden 2 and 3. The analyses concluded that the frequency for events resulting in sustained boiling was $4.3 \times 10^{-6}/\text{yr}$. This low frequency was primarily attributable to the reliability of the systems that provide cooling to the SFP. The Dresden SFP cooling system has pumps that receive power from an emergency onsite power source, and SFP cooling can be supplied from the Shutdown Cooling System which also receives backup power from an emergency onsite source.

In its response to the staff's July 26 report on the resolution of the SFP action plan, the licensee for Dresden provided an analysis of the effects of sustained SFP boiling on safety equipment in shared spaces, indicating that high humidity and temperature could threaten the equipment required to

mitigate a loss-of-coolant accident (LOCA) in an operating unit. However, the licensee noted that the SFP cooling systems, which include normal SFP cooling and shutdown cooling in the SFP cooling assist mode, are very reliable because of their redundant power supplies (i.e., two offsite sources, plus five onsite sources). The cooling systems' reliability, combined with the low probability of a concurrent LOCA plus a loss of offsite power event, makes the likelihood of a sustained SFP boiling event that affects safety equipment in the reactor building a low frequency event. The staff reviewed the licensee's evaluation, and based on our own independent probabilistic analysis, agreed with their conclusions.

For Hatch 1 and 2, the sum of event sequences that result in sustained boiling had a frequency of 4.4×10^{-6} /yr. Event sequences resulting in evaporative cooling in the SFP was the dominated contributor. Because this frequency exceeded the staff's screening criteria, additional analysis was required.

The staff found that the sustained boiling frequency for Hatch was dominated by an event sequence in which both units are initially operating. During plant operation, the non-safety related Spent Fuel Pool Cooling (SFPC) system provides cooling to the Units 1 and 2 SFPs. The Alternate Decay Heat Removal (ADHR) system, with its normal power supplied by a separate switchyard from the SFPC systems, is also available to provide SFP cooling. With neither unit in refueling, however, ADHR is not required to have its portable backup diesel generator available. An extended loss of offsite power that disables both plant switchyards would render both the SFPC and ADHR systems inoperable. The Residual Heat Removal (RHR) system can be aligned in the Fuel Pool Cooling Assist mode to provide cooling to the stored fuel, but at Hatch, this mode can only be used if the reactor vessel is aligned with the SFP in a refueling configuration. Therefore, fuel pool cooling assist mode of RHR would not be available during an extended loss of offsite power with both units configured for operation.

Several factors affect the probability of a sustained boiling event that were not included in the staff's probabilistic analysis. During normal plant operation, there is a lower decay heat load in the SFP and a longer time-to-boil compared with refueling operations. In the staff's analysis, no credit was given for any contingency actions by the licensee, such as supplying temporary power to the SFP cooling pumps during an extended power outage, or obtaining a portable diesel for the ADHR system, either of which would restore cooling to the SFP. Either of these contingency actions would lower the frequency of a sustained SFP boiling event. The staff calculated the frequency of sustained boiling during refueling at Hatch with a full core offload in one SFP, and with the alternate decay heat removal system in operation including its dedicated diesel generator aligned and ready for use, was approximately 9×10^{-6} /yr. This frequency is more consistent with the results found at Dresden. In addition, due to the extended time-to-boil at these lower decay heat loads, critical safety equipment required for safe shutdown of an operating unit should have completed its required safety functions or can be otherwise protected from the effects of the boiling pools before degradation occurs.

Regardless, the staff reviewed the effects of pool boiling on safety equipment located in shared structures. The licensee for Hatch provided an evaluation of the safety-related equipment located on the refueling floor and in the Unit 1 reactor building that could be exposed to high temperature and humidity during a pool boiling event, as well as an evaluation of the effects of flooding due to the spread of condensation throughout these spaces. The temperature and humidity qualification of the equipment was compared with the expected environment for a sustained boiling event in the SFP. Based on the existing environmental qualification of this equipment and the relatively mild environment created by the sustained boiling event, the licensee determined that it was unlikely that any safety equipment required for the safe shutdown of an operating unit would be adversely affected. The licensee also provided an analysis based on conservative assumptions of the effects of flooding due to the condensation of vapor from the boiling SFPs and concluded that adequate equipment was available for the safe shutdown of the plant. The staff reviewed the licensee's evaluations and agreed with their conclusions.

Initially, the staff selected Hatch and Dresden as lead plants for this issue because they were representative of the other plants in this category. During this review, it became apparent that the evaluations for the shared systems and structures issue were complex and plant-specific and that the results of evaluations should not be applied to the other plants in this category without further review. After reviewing the results of the Dresden and Hatch evaluations, the staff determined that plants having SFP cooling systems with backup power from onsite sources have a low likelihood of sustained boiling. Plants without onsite backup power for the SFP cooling system should receive further evaluation to determine the frequency of sustained boiling events.

The staff reviewed design features for the remaining ten plants in this category and found that eight plants have SFP cooling systems with onsite backup power. The two remaining plants (LaSalle 1 and 2) have the capability to supply onsite backup power to the SFP cooling system pumps, however, critical valves within each unit's SFP cooling system have control power circuits that are not powered from onsite sources and would fail shut during a loss-of-offsite-power event, rendering the SFP cooling system inoperable.

In their response to the staff's July 26 report, the licensee for LaSalle acknowledged this condition and informed the staff that they are taking voluntary actions to ensure the control circuits in the unit experiencing the loss of offsite power will be supplied power from the other unit's nonsafety-related source. These actions would restore the valves' function in the event of a plant-centered loss of offsite power. However, should a grid-related loss-of-offsite-power event occur, both units' control power circuits would become de-energized disabling both SFP cooling systems. The staff has determined that this configuration, unique to LaSalle, warrants further analysis to determine whether a safety enhancement is warranted.

Based on these findings, the staff has determined that no further regulatory action is warranted for eleven plants in this category. However, for LaSalle 1 and 2, the staff will continue its regulatory analysis to determine whether a plant-specific safety enhancement can be justified.

3.2.2 Absence of Onsite Power Supply for Systems Capable of SFP Cooling

A sustained loss of offsite power at plants without an onsite power supply for SFP cooling may lead to departure from subcooled decay heat removal in the fuel pool, increased thermal stress in pool structures, loss of coolant inventory, increased levels of airborne radioactivity, and adverse environmental effects in areas communicating with the SFP area. Operator actions to align a temporary power supply from an onsite source or establish alternate cooling such as feed and bleed using a diesel-powered pump, high temperature alarms, filtered ventilation, and separation and isolation of areas containing equipment important to safety from the SFP area provide protection at these plants. To address this category, the licensee's capability to supply onsite power to the SFP cooling system relative to the time available for recovery actions was evaluated relative to the risks of a loss of all cooling.

Seven plants (Surry 1 and 2, Prairie Island 1 and 2, ANO 2, and Zion 1 and 2) were identified in the staff's report on the resolution to the SFP action plan as not having onsite power available to a system available to cool the SFP. Licensees for four of the plants (Surry 1 and 2 and Prairie Island 1 and 2), notified the staff of their intentions to install backup power to their SFP cooling system pumps from an onsite source. Of the three plants remaining, the staff selected Zion 1 and 2 for review because it was representative of the remaining plant in this group.

During initial licensing, the staff reviewed the design of plants without backup power to the SFP cooling system pumps and found that the use of evaporative cooling as a backup method for SFP cooling was acceptable, provided sufficient makeup was available to maintain SFP coolant inventory. Although evaporative cooling is an available method of backup SFP cooling at these plants, it has never been used. Operating the SFP at elevated temperatures for evaporative cooling results in some adverse consequences that do not otherwise affect the safety of the stored fuel. These consequences include the inability to operate the SFP cleanup system, effects on plant operations resulting from high temperature and humidity in the spent fuel building, and long-term effects of elevated SFP temperature on the pool's concrete structure.

In response to the resolution of the SFP action plan, the licensee for Zion 1 and 2 provided an analysis that concludes that an extended loss of offsite power event combined with a failure to establish makeup to the SFP is a low probability event. The licensee calculated the frequency of this event sequence to be $2.1 \times 10^{-6}/\text{yr}$. Their evaluation did not credit their operators with any extraordinary actions, such as connecting emergency power to the SFP cooling pumps, even though sufficient time may be available to perform such actions. If the probability of a failure to connect emergency power to the pumps were considered, the licensee estimated the frequency of this event sequence to be less than $1 \times 10^{-6}/\text{yr}$.

The staff reviewed the licensee's evaluations and performed independent calculations which confirmed the licensee's conclusions for Zion. The staff found that the low frequency of an extended loss of offsite power combined

with a failure to establish makeup to the SFP was primarily based on the reliability of the SFP makeup systems and the low non-recovery probability for loss of offsite power. The staff reviewed the design of the remaining plant in this category, ANO 2, and concluded that, due to the similarity in the design of the systems that support the storage of spent fuel, the results of the probabilistic analysis performed for Zion are representative of ANO 2.

On the basis of the low likelihood of a sustained loss of offsite power, the redundant makeup systems available to compensate for a boiling event, and the design of the spent fuel storage systems that have been analyzed for boiling, the staff has determined that no further regulatory action for any plants in this category is warranted.

3.2.3 Limited SFP Decay Heat Removal Capability

Assuming a full core discharge at an equivalent time after reactor shutdown during a period of peak ultimate heat sink temperature, some plants have higher SFP equilibrium design temperatures and shorter design recovery times than other similar plants. Licensees use administrative controls on refueling operations to ensure that spent fuel temperatures are controlled within the appropriate limits. The staff has previously reviewed and approved the designs of these systems, however, the relatively high equilibrium design temperatures and short recovery times compared with other similar plants indicated the need for further review. The staff examined the administrative controls with respect to SFP temperature and available recovery time to determine the need for further actions.

The staff identified four plants (Indian Point 2 and 3, Salem 1 and 2) that have SFP cooling systems with limited decay heat removal capabilities. The staff reviewed design calculations; normal, abnormal and emergency operating procedures; and annunciator response procedures and held discussions with the licensee's SFP cooling system engineers to determine how these systems are actually operated compared with the assumptions and calculations used for their design.

Most spent fuel storage systems include a cooling system with a relatively large heat capacity designed to maintain the SFP temperature below 150 °F under all offload conditions, including the failure of a single active component. The four plants included in this category have relatively low cooling capacities. Under design conditions, which include the maximum decay heat load possible, ultimate heat sink temperature at its maximum design temperature, and the failure of a single active component, the SFP equilibrium temperature was calculated as high as 205 °F. Higher equilibrium temperatures in the SFP limit the capability of the licensee to operate the SFP cleanup system and reduce the available time operators have to make provisions to add makeup water to the pool in the event of a sustained loss of cooling. High SFP temperatures also create operational problems for operators during refueling because of the high temperature and humidity in the fuel building.

The staff reviewed operating practices and procedures from three of the four plants (Salem 1 and 2, Indian Point 2) in this category to determine whether additional administrative controls were warranted. The staff also conducted

telephone interviews with site personnel to determine the actual operating conditions under which refuelings are conducted.

Based on the conversations with the licensees contacted for this issue, administrative controls are used to limit the temperature in the SFP. The licensees indicated that pool temperature at these sites have been consistently maintained below SFP cooling system alarm setpoints, normally less than 130 °F, even under full core offload conditions.

Each licensee has procedures that direct their operators to take actions early in loss-of-cooling events to ensure temperature limits in the SFP are not exceeded. SFP high temperature alarms are typically set well below design and licensing limits to allow operators sufficient time to address any degraded conditions. Procedures require operators to take action to isolate the SFP cooling purification system and resolve the cooling inadequacy as SFP temperatures approach alarm setpoints. In some cases, operators are required to align makeup water to the pool if cooling is lost for an extended period, well in advance of pool boiling. The staff found that requiring operators to take mitigative actions to restore cooling at temperatures well below design temperatures, and make preparations to add makeup water early in a loss-of-cooling event ensures that operators will have sufficient time to establish makeup and reduces the likelihood that boiling could occur without makeup water available.

Both licensees interviewed for this issue took additional measures that ensure significant margin to SFP temperature design limits. Though not required, these licensees typically perform their refuelings in colder months to take advantage of the additional cooling from low ultimate heat sink temperatures. Although system design calculations at one plant in this category indicated that the SFP temperature could exceed 180 °F under design conditions with a full core offload, the practice of offloading when ultimate heat sink temperatures are low enables the licensee to maintain the SFP temperature below 125 °F. In addition, preventive maintenance and repairs to the cooling system are typically performed just before the refueling outage when the SFP decay heat load is low so that system malfunctions are minimized during refueling. These practices and others are not exclusive to the licensees in this category but are commonly used throughout the industry to minimize risk during shutdown operations.

In addition, the staff is currently developing a proposed rule for shutdown operations that would provide clarification and improvements in the way licensees provide administrative control over the management of decay heat.

On the basis of our review of these plant-specific practices and procedures regarding the management of decay heat during shutdown operations, and due to the staff's current actions regarding the development of proposed shutdown regulations, the staff has determined that there is no need to pursue further regulatory analysis for any of the plants in this category.

3.2.4 Infrequently Used Backup SFP Cooling Systems

Infrequently operated backup cooling systems are relied on at plants in this

category more than other similar plants because of the absence of an onsite power supply for the primary SFP cooling system or the low relative capacity of the primary cooling system. Administrative controls on refueling operations and availability of backup SFP cooling capability ensure that adequate cooling is available for the spent fuel. The staff examined the administrative controls on the availability of the backup cooling systems during refueling and technical analyses demonstrating the capability of these backup systems to determine the need for further regulatory analyses.

The staff performed a plant-specific review of this issue for four plants (Dresden 2 and 3, and Hatch 1 and 2). These plants were selected because they were determined to be representative of the six other plants in this category. These plants use a permanently installed backup system to augment SFP cooling during periods of high decay heat in the pool or during periods of maintenance when SFP cooling or other support systems are unavailable. Because these backup systems normally perform other functions or are staged in dry layup, the staff reviewed the licensees' administrative procedures for the control and use of these systems. In addition, the staff verified the capability of one backup system to perform its function as described in the licensee's final safety analysis report (FSAR).

The staff found that the licensees reviewed for this study manage decay heat using an outage safety assessment in a manner consistent with NUMARC 91-06, "Guidelines for Industry Actions To Assess Shutdown Management." Outage safety assessments provide methods for documenting the availability of systems and components that provide adequate core and fuel pool cooling, provide emergency power supplies, and provide containment. Systems available to provide primary and backup SFP cooling are identified to the operational staff through this assessment and are updated as conditions change throughout the outage period.

The staff also found that systems relied upon to provide augmented cooling to the SFP under the high heat load conditions associated with refueling at the plants in this category were aligned, inspected, and tested before the licensee began the transfer of fuel assemblies. Often these systems require spool-pieces or special system alignments to provide this cooling function. Requirements to prepare these backup systems for use were contained in the appropriate refueling procedures.

However, at one site, the licensee found that the backup cooling system could not provide the required flow rate to the SFP as described in the FSAR. The licensee performed an operability determination to verify that the actual flow of the backup cooling system would provide sufficient cooling to keep the stored fuel below its temperature limits under design conditions. The licensee found that the original design calculations were conservative and that the actual system flow rate provides sufficient cooling to the stored fuel under design conditions. The licensee plans to update its FSAR with the latest design parameters and the results of the updated calculations, as appropriate.

On the basis of the staff's findings that the backup cooling systems are used regularly during refueling outages, the systems are aligned and tested by

administrative procedures before the commencement of fuel offload, and administrative controls are in place to manage decay heat during refuel periods, the staff has determined that no further regulatory action is required on this issue.

3.2.5 Limited Instrumentation for Loss of Cooling Events

The capability of instrumentation to alert operators to a sustained loss of SFP cooling is limited at certain plants. Fuel storage pools at most sites have direct temperature indication. However, some sites rely on temperature indication in the SFP cooling and cleanup system (SFPCS) to provide an indication of the temperature of the coolant in the pool. A loss of flow in the SFPCS would prevent operators from monitoring the temperature of the pool and could lead to delays in identifying a loss-of-cooling event. Related alarms, along with operating procedures, and operator identification would provide protection for the stored fuel if a loss-of-cooling event occurred. The staff evaluated this issue to determine whether additional instrumentation or operational controls were warranted on a safety enhancement basis at these plants.

The staff identified 10 plants (ANO 1, Big Rock Point, Brunswick 1 and 2, Cooper, Hatch 1 and 2, LaSalle 1 and 2, and Millstone 1) that had limited temperature instrumentation for loss-of-cooling events and selected the Hatch facility for this assessment because the Hatch plant configuration was representative of the other plants in this category and it also had other design features being evaluated as part of this study. The staff visited the site to document the instrumentation and procedures available to the operators to control and monitor cooling of the stored fuel in the SFP so that they could be used to construct a plant-specific probabilistic analysis. This information was used to assess the effects of having limited temperature indication during loss-of-cooling events.

The probabilistic analysis performed at Hatch indicated a low likelihood of sustained loss-of-cooling events and loss-of-inventory events. The staff found no indication that the lack of direct temperature indication significantly increased the likelihood associated with identifying or mitigating loss-of-cooling events in the SFP. Alternate instrumentation available to operators provides indication and alarm (e.g., SFP cooling and cleanup temperature indication). Administrative controls that are put in place when SFP cooling is secured or becomes otherwise disabled (e.g., installing temporary temperature indication in the pool if cooling is lost for a significant period) provide adequate information to operators concerning the status of pool cooling.

On the basis of the available alternate instrumentation, administrative controls, and the low frequency of loss-of-cooling events and loss-of-inventory events associated with the lack of direct temperature instrumentation for the SFP, the staff has determined that further regulatory actions on this issue are not warranted.

4.0 SUMMARY

The staff has completed its actions to perform plant-specific evaluations and regulatory analyses of issues that were identified in the resolution of the SFP action plan and the AEOD study on SFP cooling and provides the following summary of issues and resolutions.

In their response to the staff's report dated July 26, 1996, 12 licensees volunteered to perform actions ranging from procedural changes to plant modifications. A list of these licensees and their proposed actions is presented in Table 2. The staff reviewed the licensees' voluntary actions and agreed that they address the issues identified in the staff's July 26 report for their respective plants. The staff will track the licensees' actions using the Commitment Tracking System to ensure the underlying issue is resolved in a timely manner.

For the four plants in the category "Absence of Passive Antisiphon Devices on Piping Extending Below the Top of the Stored Fuel," the proposed actions by these licensees, which include modifications to the plants (e.g., valve removal or installation of a permanent locking device) and administrative controls that further reduce the probability that these valves could be inadvertently operated, resolve the staff's concerns on this issue. Therefore, no further regulatory action is warranted.

For the categories "Transfer Tube(s) Within the SFP Rather Than a Separate Transfer Canal," and "Piping Entering the Pool Below the Top of the Stored Fuel," Oconee was evaluated because it has the most transfer tubes penetrating the SFPs, and is the only site that has an interfacing system. The results of the staff's probabilistic analysis indicated a low likelihood (less than $1 \times 10^{-6}/\text{yr}$) that stored fuel could become uncovered, indicating that this design feature is of relatively low risk-significance. On this basis, no further regulatory action will be taken for the plants in this category.

The staff's evaluation of the "Limited Instrumentation for Loss-of-Coolant Events" and "Limited Instrumentation for Loss of Cooling Events," determined that no event sequence resulted in a SFP level one foot above the top of the fuel storage racks with a frequency greater than $1 \times 10^{-6}/\text{yr}$, and there was no indication that the lack of direct temperature indication significantly increased the likelihood associated with identifying or mitigating loss-of-cooling events in the SFP. Also, alternate instrumentation and administrative controls are available to operators to provide information concerning the status of pool cooling. Therefore, no further regulatory actions will be taken for the plants in these categories.

For the five plants in the category of "Absence of Leak Detection Capability or Absence of Isolation Valves in Leakage Detection System Piping," the staff found that the licensees performed the necessary evaluations to ensure that the available makeup rate to the SFP exceeded the leakage rate for credible leakage scenarios. Therefore, no further regulatory action is warranted.

The category entitled "SFP Loss of Inventory Through Failure of the Refueling Cavity Seal" was added to this study as a result of AEOD's review of SFP

cooling. The staff evaluated the design and licensing of three BWR refueling cavity seals, and found that no further regulatory action is warranted regarding this design feature. The staff based this finding on the staff's conclusions in NUREG/CR-4525 concerning the acceptability of the refueling cavity seal designs at Nine Mile Point 2 and Limerick 1 and 2, the results of this review, and the low probability of a seal failure resulting in spent fuel damage as documented in NUREG-1353.

The staff performed regulatory analyses for three of thirteen plants in the category "Shared Systems and Structures at Multi-Unit Sites," and reviewed the designs of the other ten plants to ensure that the results of the regulatory analysis were applicable to these plants. The staff found that at plants where the systems cooling the SFP have backup power from onsite sources, there is a low likelihood of events that result in the sustained boiling of the SFP. Because Hatch does not supply backup power from an onsite source to their available SFP cooling systems during normal plant operation, the staff evaluated the effects of sustained boiling on equipment required for the safe shutdown of the reactor. The staff found that the qualification of this equipment exceeded the expected environment created by boiling in the SFP and that potential flooding caused by condensation would not threaten any vital equipment. During the review of the remaining plants in this category, the staff determined that LaSalle 1 and 2 may experience sustained boiling during certain loss-of-offsite-power events, and that further evaluation is necessary to determine whether a plant-specific safety enhancement is warranted. For the other eleven plants in this category, the staff has determined that further evaluation is not warranted.

The staff found that no further regulatory action was necessary for the category "Absence of Onsite Power Supply for Systems Capable of SFP Cooling" on the basis of the low likelihood of a sustained loss of offsite power, the redundant and reliable makeup systems available to compensate for a boiling event, and the design of the spent fuel storage systems that have been analyzed for boiling.

For the four plants that have SFP cooling systems under the category "Limited SFP Decay Heat Removal Capability," the staff found that there is no need to perform any further regulatory analysis based on existing licensee practices and procedures for managing decay heat in the SFP. Even though the plants in this category are susceptible to relatively high SFP temperatures due to the design of their spent fuel storage systems, the staff found these licensees employ practices to limit the SFP temperatures to below the SFP cooling system alarm setpoints which are set significantly below design limits and have administrative controls in place to add makeup water early in a loss-of-cooling event. The staff is also in the process of formulating regulations to clarify and improve the way licensees manage decay heat during shutdown operations.

Four plants were evaluated under the category "Infrequently Used Backup SFP Cooling Systems." The staff found that these backup cooling systems are used regularly during refueling outages, that the systems are aligned and tested by administrative procedures before the commencement of fuel offload, and that administrative controls used manage decay heat during refuel periods. At one

dual unit site, however, the staff found that the backup system could not provide the cooling flow rate described in the FSAR. The licensee has performed the necessary calculations to ensure the system is capable of providing adequate cooling to the SFP and will update their FSAR. Based on these findings, the staff found no need to pursue further regulatory action.

The staff has completed its actions to perform the evaluations and regulatory analyses identified in our July 26 report to the Commission on resolution to the SFP action plan. Other planned actions identified in resolution to the SFP action plan report, which include rulemaking and revising the staff guidance for SFP evaluations, are still under development. The staff has issued SECY-97-168, "Issuance for Public Comment of Proposed Rulemaking Package for Shutdown and Fuel Storage Pool Operation," requesting Commission approval to release for public comment the proposed rule on shutdown operations. Revision of the staff's SFP evaluation guidance documents will be completed by October 1998, as described in our response to the Staff Requirements Memorandum dated October 2, 1996.

TABLE 1
SFP DESIGN FEATURES IDENTIFIED IN THE JULY 26 REPORT

Category	Review	Plant	Source
Absence of Passive Antisiphon Devices on Piping Extending Below the Top of the Stored Fuel	Regulatory Analysis	<u>Robinson</u> , Davis-Besse, Turkey Point	NRR
Transfer Tube(s) Within the SFP Rather Than a Separate Transfer Canal	Regulatory Analysis	<u>Oconee</u> *, Crystal River, Maine Yankee	NRR
Piping Entering the Pool Below the Top of the Stored Fuel	Regulatory Analysis	<u>Oconee</u> *	NRR
Limited Instrumentation for Loss-of-Coolant Events	Regulatory Analysis	<u>Dresden</u> *, <u>Hatch</u> *, Big Rock Point, Peach Bottom	NRR
Absence of Leak Detection Capability or Absence of Isolation Valves in Leakage Detection System Piping	Additional Information	<u>Indian Point 2</u> , <u>Salem</u> , D.C. Cook	NRR
Shared Systems and Structures at Multi-Unit Sites	Regulatory Analysis	<u>Dresden</u> *, <u>Hatch 1</u> *, Calvert Cliffs, D.C. Cook, LaSalle, Point Beach, Quad Cities	NRR
Absence of Onsite Power Supply for Systems Capable of SFP Cooling	Regulatory Analysis	<u>Zion</u> , ANO 2, Prairie Island, Surry	NRR
Limited SFP Decay Heat Removal Capability	Additional Information	<u>Indian Point 2</u> , <u>Salem</u>	NRR
Infrequently Used Backup SFP Cooling Systems	Additional Information	<u>Dresden</u> *, <u>Hatch</u> *, Browns Ferry, Davis-Besse, Fermi, FitzPatrick, WNP-2	NRR
Limited Instrumentation for Loss-of-Cooling Events	Regulatory Analysis	<u>Hatch</u> *, ANO-1, Big Rock Point, Brunswick, Cooper, LaSalle, Millstone	NRR
Refueling Cavity Seals with Pneumatic Components	Additional Information	<u>Limerick</u> , <u>Nine Mile Point 2</u>	AEOD

Notes:

- The underlined plant(s) was selected as the lead review plant(s) for each category. Design features at these plants represented the most rigorous backfit tests for the regulatory analysis categories. Site visits were conducted at plants designated with an asterisk (*).
- NRR: Resolution of the Spent Fuel Storage Pool Action Plan Issues, July 26, 1996.
AEOD: Assessment of Spent Fuel Cooling, October 3, 1996.

TABLE 2
SFP REGULATORY ANALYSIS LICENSEE VOLUNTARY ACTIONS

<i>Plant Name</i>	<i>SFP Issue (see notes)</i>	<i>Voluntary Actions Described in Submittal</i>
Crystal River	2	Procedural revisions are to be made to assure that fuel transfer canal and fuel transfer tube drain valves are closed and locked prior to removal of fuel transfer covers. Procedures will be revised to specify order of equipment removal for fuel transfer operations
Davis-Besse	1	For issue 1 (siphon), licensee plans to lock closed or remove handwheel from valve to prevent potential misoperation. Licensee feels that back-up systems are adequate.
Dresden 2 and 3	4	Administrative controls to locally monitor SFP level during periods without forced SFP cooling or during a loss of AC power will be included in site procedures.
LaSalle 1 and 2	10	Licensee will either perform a modification to provide control power from either unit's normal offsite power, 6.9 kV supply, or proceduralize a method to restore power to the control circuit in the event of a loss of offsite power.
Oconee 1, 2 and 3	2,3	Licensee has committed to upgrading procedures to clarify event sequences for fuel transfer preparation activities.
Peach Bottom	4	Licensee plans to install low-level switches in the SFP which would alarm locally and provide a general SFP trouble alarm in the main Control Room. Switches to be installed by September 30, 1997.
Prairie Island 1 and 2	7	Licensee has modified the SFP cooling system to include a power supply from an onsite safety-related source.
Robinson	1	Licensee plans to blank the piping from the spent fuel pool to prevent siphoning. Modifications to the piping are expected to be completed by September 1997.
Salem 1 and 2	8	Commitments made in August 2, 1996 letter to develop enhanced administrative controls for SFP Decay Heat Load Management
Surry 1 and 2	7	Surry has changed (lowered) SFP high temp alarm setpoint, added procedural controls to provide further actions to restore SFP cooling in the event of LOOP, and initiated a design change to provide emergency power to SFP cooling pumps. Licensee will notify the staff of the finalization of the design change.
Turkey Point 3 and 4	1	The licensee has welded a chain around the valve in question to permanently lock it shut. In addition there are administrative controls and a tag on the valve which warns that it cannot be opened without the approval of the Plant General Manager and Licensing Manager.
Zion	7	Licensee has committed to modify procedures to more specifically identify the work necessary to provide the temporary power to the SFP Cooling water pumps. In addition, dedicated and staged cabling and other required equipment will be provided. Procedure AOP-6.4 will be revised to account for the removal of the block wall between the Fuel Handling Building and Containment. Licensee maintains that adequate make-up is available to maintain pool level, should maximum leakage occur via the leakage detection system.

Notes:

SFP Issues:

1. Absence of Passive Antisiphon Devices on Piping Extending Below Top of Stored Fuel
2. Transfer Tube(s) Within SFP Rather Than Separate Transfer Canal
3. Piping Entering Pool Below Top of Stored Fuel
4. Limited Instrumentation for Loss of Coolant Events
5. Absence of Leak Detection Capability or Absence of Isolation Valves in Leakage Detection System Piping

6. Shared Systems and Structures at Multi-Unit Sites
7. Absence of On-site Power Supply for Systems Capable of SFP Cooling
8. Limited SFP Decay Heat Removal Capability
9. Infrequently Used Backup SFP Cooling Systems
10. Limited Instrumentation for Loss of Cooling Events

Regulatory Analysis for the Resolution of Generic Issue 82, “Beyond Design Basis Accidents in Spent Fuel Pools”

**U.S. Nuclear Regulatory
Commission**

Office of Nuclear Regulatory Research

E. D. Throm



Coe, Doug

From: Helton, Donald
Sent: Wednesday, April 13, 2011 2:30 PM
To: Correia, Richard; Coyne, Kevin
Cc: Coe, Doug; Tobin, Margaret
Subject: RE: Request for SFP Information

Rich,

Yes, it does make sense. We had mentioned this document in the GI-82 excerpt, but we can add it explicitly. We can also add the SFP action plan material. We further need to add the Alvarez report and agency response now that we have the time.

Speaking of time, do you know the next intended use of the tables? I ask because I'll be out of the office from Friday – Tuesday and would like to know the urgency of getting them updated.

Best,
Don

From: Correia, Richard
Sent: Wednesday, April 13, 2011 2:24 PM
To: Helton, Donald; Coyne, Kevin
Cc: Coe, Doug
Subject: FW: Request for SFP Information

Don,

FYI...Steve recommends your table be supplemented with information below and from the attached.

Make sense?

Rich

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Jones, Steve
Sent: Wednesday, April 13, 2011 2:18 PM
To: Correia, Richard
Cc: Lee, Samson; Check, Michael; Collins, Timothy; Bowman, Eric
Subject: RE: Request for SFP Information

Rich,

I recommend adding the attached documents to the summary. The ADAMS accession numbers are in the file name.

44/484

NUREG-1353 described resolution of Generic Issue, 82, "Beyond Design Basis Accidents in Spent Fuel Pools," which was the first comprehensive evaluation of expanding requirements for fuel pool cooling. The followup actions paper on the SFP action plan describes voluntary measures implemented at many plants in the late 1990's to bring the plants closer to conformance with existing guidelines relative to spent fuel storage safety. These measures included adding level instrumentation, blocking potential siphon paths, managing potential coolant loss through the liner leak collection system, and establishing measures to power spent fuel pool cooling pumps from on-site power.

Thanks!

Steve

Steven R. Jones
Sr. Reactor Systems Engineer
NRR/DSS/SBPB
301-415-2712

From: Cheok, Michael
Sent: Wednesday, April 13, 2011 1:36 PM
To: Collins, Timothy; Bowman, Eric; Jones, Steve
Cc: Lee, Samson
Subject: FW: Request for SFP Information

FYI

From: Correia, Richard
Sent: Wednesday, April 13, 2011 1:29 PM
To: Bowman, Gregory; Cheok, Michael
Subject: RE: Request for SFP Information

Greg, Mike,

We just created the attached table on SFP studies. It contains a lot of information including document titles and ADAMS references. This should be a very good start.

Let us know if this is sufficient or if a sit down meeting is still preferred.

Rich

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Bowman, Gregory
Sent: Wednesday, April 13, 2011 12:45 PM
To: Correia, Richard; Cheok, Michael
Subject: Request for SFP Information

Rich and Mike,

We got a request from Andrea Kock in Commissioner Ostendorff's office. She's looking for some help finding background information on spent fuel pool safety, primarily to help her prepare for the April 29 meeting. She and her Commissioner strongly emphasized that they don't want the staff to write anything for them – Andrea is really just looking for someone who can point her to documents she can read to get prepared for the briefing. We'd most likely end up sending the same list to the other Commission offices, which in the end may help head off the need to conduct similar Commissioner briefings for the other offices.

Do you have someone who we can put Andrea in touch with? She tried to do this on her own, but had a lot of trouble finding things. It sounds like it wouldn't be large time commitment, maybe just a phone call or sit down with her, and then coming up with ML numbers for the background material she needs. If we can do it in person, which I think would be preferred, I can go along to make sure we're getting her what she needs and we're not taking on too much work.

Greg

Coe, Doug

From: Correia, Richard
Sent: Wednesday, April 13, 2011 2:32 PM
To: Coyne, Kevin; Helton, Donald
Cc: Coe, Doug
Subject: FW: Request for SFP Information

Don,

Another suggestion..does it fit in with your other items?

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Bowman, Eric
Sent: Wednesday, April 13, 2011 2:25 PM
To: Correia, Richard
Cc: Lee, Samson; Cheok, Michael; Collins, Timothy; Jones, Steve
Subject: RE: Request for SFP Information

Rich,

I would suggest the B.5.b History memo for background reading on the subject of post 9/11 requirements. It's in ADAMS at ML092990438.

Thanks!

Eric

From: Jones, Steve
Sent: Wednesday, April 13, 2011 2:18 PM
To: Correia, Richard
Cc: Lee, Samson; Cheok, Michael; Collins, Timothy; Bowman, Eric
Subject: RE: Request for SFP Information

Rich,

I recommend adding the attached documents to the summary. The ADAMS accession numbers are in the file name.

NUREG-1353 described resolution of Generic Issue, 82, "Beyond Design Basis Accidents in Spent Fuel Pools," which was the first comprehensive evaluation of expanding requirements for fuel pool cooling. The followup actions paper on the SFP action plan describes voluntary measures implemented at many plants in the late 1990's to bring the plants closer to conformance with existing guidelines relative to spent fuel storage safety. These measures included adding level instrumentation, blocking potential siphon paths, managing potential coolant loss through the liner leak collection system, and establishing measures to power spent fuel pool cooling pumps from on-site power.

Thanks!

44/485

Steve

Steven R. Jones
Sr. Reactor Systems Engineer
NRR/DSS/SBPB
301-415-2712

From: Cheok, Michael
Sent: Wednesday, April 13, 2011 1:36 PM
To: Collins, Timothy; Bowman, Eric; Jones, Steve
Cc: Lee, Samson
Subject: FW: Request for SFP Information

FYI

From: Correia, Richard
Sent: Wednesday, April 13, 2011 1:29 PM
To: Bowman, Gregory; Cheok, Michael
Subject: RE: Request for SFP Information

Greg, Mike,

We just created the attached table on SFP studies. It contains a lot of information including document titles and ADAMS references. This should be a very good start.

Let us know if this is sufficient or if a sit down meeting is still preferred.

Rich

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Bowman, Gregory
Sent: Wednesday, April 13, 2011 12:45 PM
To: Correia, Richard; Cheok, Michael
Subject: Request for SFP Information

Rich and Mike,

We got a request from Andrea Kock in Commissioner Ostendorff's office. She's looking for some help finding background information on spent fuel pool safety, primarily to help her prepare for the April 29 meeting. She and her Commissioner strongly emphasized that they don't want the staff to write anything for them – Andrea is really just looking for someone who can point her to documents she can read to get prepared for the briefing. We'd most likely end up sending the same list to the other Commission offices, which in the end may help head off the need to conduct similar Commissioner briefings for the other offices.

Do you have someone who we can put Andrea in touch with? She tried to do this on her own, but had a lot of trouble finding things. It sounds like it wouldn't be large time commitment, maybe just a phone call or sit down with her, and then coming up with ML numbers for the background material she needs. If we can do it in

person, which I think would be preferred, I can go along to make sure we're getting her what she needs and we're not taking on too much work.

Greg

Coe, Doug

From: Correia, Richard
Sent: Wednesday, April 13, 2011 2:34 PM
To: Helton, Donald; Coyne, Kevin
Cc: Coe, Doug; Tobin, Margaret
Subject: RE: Request for SFP Information

Thx Don. Nothing urgent about updating the table. I sent it up to the OEDO for Commissioner TA use in preparation for the 4/29 briefing on SAF poll risk. I can send up these other items separately for now.

Rich

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Helton, Donald
Sent: Wednesday, April 13, 2011 2:30 PM
To: Correia, Richard; Coyne, Kevin
Cc: Coe, Doug; Tobin, Margaret
Subject: RE: Request for SFP Information

Rich,

Yes, it does make sense. We had mentioned this document in the GI-82 excerpt, but we can add it explicitly. We can also add the SFP action plan material. We further need to add the Alvarez report and agency response now that we have the time.

Speaking of time, do you know the next intended use of the tables? I ask because I'll be out of the office from Friday – Tuesday and would like to know the urgency of getting them updated.

Best,
Don

From: Correia, Richard
Sent: Wednesday, April 13, 2011 2:24 PM
To: Helton, Donald; Coyne, Kevin
Cc: Coe, Doug
Subject: FW: Request for SFP Information

Don,

FYI...Steve recommends your table be supplemented with information below and from the attached.

Make sense?

Rich

Richard Correia, PE

XX/486

Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Jones, Steve
Sent: Wednesday, April 13, 2011 2:18 PM
To: Correia, Richard
Cc: Lee, Samson; Cheok, Michael; Collins, Timothy; Bowman, Eric
Subject: RE: Request for SFP Information

Rich,

I recommend adding the attached documents to the summary. The ADAMS accession numbers are in the file name.

NUREG-1353 described resolution of Generic Issue, 82, "Beyond Design Basis Accidents in Spent Fuel Pools," which was the first comprehensive evaluation of expanding requirements for fuel pool cooling. The followup actions paper on the SFP action plan describes voluntary measures implemented at many plants in the late 1990's to bring the plants closer to conformance with existing guidelines relative to spent fuel storage safety. These measures included adding level instrumentation, blocking potential siphon paths, managing potential coolant loss through the liner leak collection system, and establishing measures to power spent fuel pool cooling pumps from on-site power.

Thanks!

Steve

Steven R. Jones
Sr. Reactor Systems Engineer
NRR/DSS/SBPB
301-415-2712

From: Cheok, Michael
Sent: Wednesday, April 13, 2011 1:36 PM
To: Collins, Timothy; Bowman, Eric; Jones, Steve
Cc: Lee, Samson
Subject: FW: Request for SFP Information

FYI

From: Correia, Richard
Sent: Wednesday, April 13, 2011 1:29 PM
To: Bowman, Gregory; Cheok, Michael
Subject: RE: Request for SFP Information

Greg, Mike,

We just created the attached table on SFP studies. It contains a lot of information including document titles and ADAMS references. This should be a very good start.

Let us know if this is sufficient or if a sit down meeting is still preferred.

Rich

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Bowman, Gregory
Sent: Wednesday, April 13, 2011 12:45 PM
To: Correia, Richard; Cheek, Michael
Subject: Request for SFP Information

Rich and Mike,

We got a request from Andrea Kock in Commissioner Ostendorff's office. She's looking for some help finding background information on spent fuel pool safety, primarily to help her prepare for the April 29 meeting. She and her Commissioner strongly emphasized that they don't want the staff to write anything for them – Andrea is really just looking for someone who can point her to documents she can read to get prepared for the briefing. We'd most likely end up sending the same list to the other Commission offices, which in the end may help head off the need to conduct similar Commissioner briefings for the other offices.

Do you have someone who we can put Andrea in touch with? She tried to do this on her own, but had a lot of trouble finding things. It sounds like it wouldn't be large time commitment, maybe just a phone call or sit down with her, and then coming up with ML numbers for the background material she needs. If we can do it in person, which I think would be preferred, I can go along to make sure we're getting her what she needs and we're not taking on too much work.

Greg

Coe, Doug

From: Correia, Richard
Sent: Wednesday, April 13, 2011 2:27 PM
To: Salley, MarkHenry
Cc: Rini, Brett; Marksberry, Don; Coe, Doug
Subject: RE: List of Issues and Research Areas from Japanese Event

Thx Mark. Brian has seen several international requests for information, meeting attendance etc. He is asking OIP to coordinate these activities for all program offices. I'll let you know what I find out about OIPs role and plans for these requests.

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Salley, MarkHenry
Sent: Tuesday, April 12, 2011 11:07 AM
To: Correia, Richard
Cc: Rini, Brett; Marksberry, Don; Coe, Doug
Subject: RE: List of Issues and Research Areas from Japanese Event

Rich,

Please see the attached email for your consideration.

Background:

Shortly after the H2 explosions at Fukushima, I received this request for joint H2 research from researchers in Italy. I expect there will be numerous interest for post-Fukushima research worldwide and may be something to discuss w/ Brian for him to consider long-term planning.

MHS

From: Correia, Richard
Sent: Tuesday, April 12, 2011 8:55 AM
To: Barnes, Valerie; Beasley, Benjamin; Coe, Doug; Coyne, Kevin; Demoss, Gary; Hudson, Daniel; Ott, William; Peters, Sean; Salley, MarkHenry; Hudson, Daniel; Nicholson, Thomas; Siu, Nathan; Stutzke, Martin
Subject: FW: List of Issues and Research Areas from Japanese Event

All,

Brett Rini has compiled and sorted RES staff input (attached) for the Japan events task force's consideration. Please take a look at his list and annotate any changes/corrections/clarifications keeping in mind how the task force will interpret what will be sending them (i.e., will they understand what we are asking them to consider).

Please send your comments/additions/clarifications back to me and Doug.

thanks

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research

44/487

US NRC

richard.correia@nrc.gov

From: Rini, Brett

Sent: Monday, April 11, 2011 5:27 PM

To: Case, Michael; Richards, Stuart; Correia, Richard; Coe, Doug; Gibson, Kathy; Scott, Michael; Valentin, Andrea

Cc: Sheron, Brian; Uhle, Jennifer

Subject: List of Issues and Research Areas from Japanese Event

Division Directors,

Please find attached a list of possible issues and research areas to follow-up on as a result of the Japanese earthquake. I compiled the input I received from your divisions along with a document that Brian sent me and classified the recommendations into various areas (e.g., electrical, severe accidents, external events).

Please review the attached document and let me know if you have any additional thoughts or changes.

Thanks,

Brett

Brett A. Rini

Technical Assistant

Office of Nuclear Regulatory Research

U.S. Nuclear Regulatory Commission

(301)251-7615

Brett.Rini@nrc.gov

Coe, Doug

From: Correia, Richard
Sent: Wednesday, April 13, 2011 2:38 PM
To: Siu, Nathan; Coe, Doug
Subject: RE: List of Issues and Research Areas from Japanese Event

Thanks Nathan. We'll forward them up to Brett Rini for consolidation.

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Siu, Nathan
Sent: Tuesday, April 12, 2011 11:28 AM
To: Correia, Richard; Coe, Doug
Subject: RE: List of Issues and Research Areas from Japanese Event

Rich/Doug –

Here are some potential additions stemming from things I've heard about Fukushima. Some of them may be implicitly included in existing bullets but I thought they're worth bringing out, given the nature of the list. Some also come from thoughts following NRC's post-9/11 work. I haven't vetted these with other folks – not sure of the timeline Brett is working to – but would be happy to discuss.

Nathan

From: Correia, Richard
Sent: Tuesday, April 12, 2011 8:55 AM
To: Barnes, Valerie; Beasley, Benjamin; Coe, Doug; Coyne, Kevin; Demoss, Gary; Hudson, Daniel; Ott, William; Peters, Sean; Salley, MarkHenry; Hudson, Daniel; Nicholson, Thomas; Siu, Nathan; Stutzke, Martin
Subject: FW: List of Issues and Research Areas from Japanese Event

All,

Brett Rini has compiled and sorted RES staff input (attached) for the Japan events task force's consideration. Please take a look at his list and annotate any changes/corrections/clarifications keeping in mind how the task force will interpret what will be sending them (i.e., will they understand what we are asking them to consider).

Please send your comments/additions/clarifications back to me and Doug.

thanks

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

YX/488

From: Rini, Brett

Sent: Monday, April 11, 2011 5:27 PM

To: Case, Michael; Richards, Stuart; Correia, Richard; Coe, Doug; Gibson, Kathy; Scott, Michael; Valentin, Andrea

Cc: Sheron, Brian; Uhle, Jennifer

Subject: List of Issues and Research Areas from Japanese Event

Division Directors,

Please find attached a list of possible issues and research areas to follow-up on as a result of the Japanese earthquake. I compiled the input I received from your divisions along with a document that Brian sent me and classified the recommendations into various areas (e.g., electrical, severe accidents, external events).

Please review the attached document and let me know if you have any additional thoughts or changes.

Thanks,

Brett

Brett A. Rini

Technical Assistant

Office of Nuclear Regulatory Research

U.S. Nuclear Regulatory Commission

(301)251-7615

Brett.Rini@nrc.gov

From: Beasley, Benjamin
To: Coe, Doug; Correia, Richard; Coyne, Kevin; Demoss, Gary; Ott, William; Peters, Sean; Salley, MarkHenry
Date: Wednesday, April 13, 2011 4:59:22 PM

For your information from today's OpE Clearinghouse:

1) CALIFORNIA COASTAL COMMISSION REPORT SAYS MOST CALIFORNIA FAULTS COULD NOT PRODUCE 9.0 MAGNITUDE QUAKE

A Coastal Commission Report Says Most California Faults Could Not Produce 9.0 Magnitude Quake. The Capitol Weekly (4/12/2011, Howard) reports, "Despite 1,100 miles of coastline and a history of powerful earthquakes, most of California is not susceptible to the kind of temblor and tsunami that devastated Japan, according to a report by the California Coastal Commission."

However, the Cascadia Subduction Zone is a "jumble" of tectonic plates that "meet deep below the earth's continental crust," and "could produce a quake – and tsunami – on the scale of Japan's Tohoku Quake." But, according to a 21-page study by staff geologist Mark Johnsson, "the majority of faults in California, including the San Andreas fault, could not produce a magnitude 9.0 earthquake and that most of the state 'is not susceptible to an event on the scale" of the quake that struck Japan

Click hyperlink to view the 21-page study:
http://www.coastal.ca.gov/energy/Tohoku_Earthquake_Report.pdf

Pass info and report link to TRGs for Structural, Spent Fuel Handling, Service Water /UHS, Primary Materials/ Vessel/Welding, Flood protection/missiles, and Electric Power and Research POC. Assigned to Mark King.

2) ELECTRIC POWER RESEARCH INSTITUTE - TECHNICAL FOUNDATION OF REACTOR SAFETY, REVISION 1 - KNOWLEDGE BASE FOR RESOLVING SEVERE ACCIDENT ISSUES 1022186, FINAL REPORT, OCTOBER 2010

This EPRI report compiles relevant information about actual events involving unintentional fission product releases. The type of events to be considered include those in which the fission product inventory was contained within a surrounding structure or building and those where fission products escaped to the outside environment. This compilation includes available information about doses to workers and to the public. Potential severe accident challenges such as steam explosion, direct containment heating, and hydrogen combustion are discussed, as are EPRI- and NRC-sponsored containment integrity experiments.

Click hyperlink: http://my.epri.com/portal/server.pt?Abstract_id=000000000001022186

YX/489

From: Coe, Doug
To: Beasley, Benjamin; Correia, Richard; Coyne, Kevin; Demoss, Gary; Ott, William; Peters, Sean; Salley, MarkHenry
Cc: Siu, Nathan; Helton, Donald
Subject: Severe accident knowledge base
Date: Wednesday, April 13, 2011 5:07:50 PM

Thanks Ben –

The reference to the EPRI knowledge-base on resolving severe accident issues may be valuable if we end up screening suggested research topics for possible followup (Nathan – please take note).

Thanks,
Doug

From: Beasley, Benjamin
Sent: Wednesday, April 13, 2011 4:59 PM
To: Coe, Doug; Correia, Richard; Coyne, Kevin; Demoss, Gary; Ott, William; Peters, Sean; Salley, MarkHenry
Subject:

For your information from today's OpE Clearinghouse:

1) CALIFORNIA COASTAL COMMISSION REPORT SAYS MOST CALIFORNIA FAULTS COULD NOT PRODUCE 9.0 MAGNITUDE QUAKE

A Coastal Commission Report Says Most California Faults Could Not Produce 9.0 Magnitude Quake. The Capitol Weekly (4/12/2011, Howard) reports, "Despite 1,100 miles of coastline and a history of powerful earthquakes, most of California is not susceptible to the kind of temblor and tsunami that devastated Japan, according to a report by the California Coastal Commission."

However, the Cascadia Subduction Zone is a "jumble" of tectonic plates that "meet deep below the earth's continental crust," and "could produce a quake – and tsunami – on the scale of Japan's Tohoku Quake." But, according to a 21-page study by staff geologist Mark Johnsson, "the majority of faults in California, including the San Andreas fault, could not produce a magnitude 9.0 earthquake and that most of the state 'is not susceptible to an event on the scale" of the quake that struck Japan

Click hyperlink to view the 21-page study:
http://www.coastal.ca.gov/energy/Tohoku_Earthquake_Report.pdf

Pass info and report link to TRGs for Structural, Spent Fuel Handling, Service Water /UHS, Primary Materials/ Vessel/Welding, Flood protection/missiles, and Electric Power and Research POC. Assigned to Mark King.

2) ELECTRIC POWER RESEARCH INSTITUTE - TECHNICAL FOUNDATION OF REACTOR SAFETY, REVISION 1 - KNOWLEDGE BASE FOR RESOLVING SEVERE ACCIDENT ISSUES 1022186, FINAL REPORT, OCTOBER 2010

This EPRI report compiles relevant information about actual events involving unintentional fission product releases. The type of events to be considered include those in which the

44/490

fission product inventory was contained within a surrounding structure or building and those where fission products escaped to the outside environment. This compilation includes available information about doses to workers and to the public. Potential severe accident challenges such as steam explosion, direct containment heating, and hydrogen combustion are discussed, as are EPRI- and NRC-sponsored containment integrity experiments.

Click hyperlink: http://my.epri.com/portal/server.pt?Abstract_id=000000000001022186

Coe, Doug

From: Correia, Richard
Sent: Thursday, April 14, 2011 8:32 AM
To: EDO_Calendar Resource; Case, Michael; Coe, Doug; Gibson, Kathy; Richards, Stuart; Scott, Michael; Uhle, Jennifer; Valentin, Andrea; Bowman, Gregory
Subject: RE: Briefing for Commissioners Svinicki and Apostolakis on SFP Safety

Charlie Tinkler is our presenter. Myself, Don Helton, Ken Armstrong, Kathy Gibson, Mike Scott, Kevin Coyne, Jason Schaperow are contributors/support staff. NRR will have 2 presenters: Steve Jones and Eric Bowman. NRO, NMSS & NSIR will be attending should there be questions on new reactors or ISFSIs. A separate briefing on ISFSIs will be arranged.

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

-----Original Appointment-----

From: Sheron, Brian **On Behalf Of** EDO_Calendar Resource
Sent: Thursday, April 14, 2011 8:06 AM
To: Case, Michael; Coe, Doug; Correia, Richard; Gibson, Kathy; Richards, Stuart; Scott, Michael; Uhle, Jennifer; Valentin, Andrea
Subject: FW: Briefing for Commissioners Svinicki and Apostolakis on SFP Safety
When: Friday, April 29, 2011 10:00 AM-11:30 AM (GMT-05:00) Eastern Time (US & Canada).
Where: O-2B6

FYI. Remind me again who from RES is participating in this?

-----Original Appointment-----

From: EDO_Calendar Resource
Sent: Thursday, April 14, 2011 6:34 AM
To: EDO_Calendar Resource; Ordaz, Vonna; White, Bernard; Layton, Michael; Wastler, Sandra; Sheron, Brian; Melendez, Israel; Rutz, Wayne; Frazier, Alan; Bowman, Gregory; Wittick, Brian; Wertz, Trent; Correia, Richard; Gibson, Kathy; Cheok, Michael
Subject: FW: Briefing for Commissioners Svinicki and Apostolakis on SFP Safety
When: Friday, April 29, 2011 10:00 AM-11:30 AM (GMT-05:00) Eastern Time (US & Canada).
Where: O-2B6

When: Friday, April 29, 2011 10:00 AM-11:30 AM (GMT-05:00) Eastern Time (US & Canada).
Where: O-2B6

Note: The GMT offset above does not reflect daylight saving time adjustments.

~~*~*~*~*~*~*~*~*

44/491

-----Original Appointment-----

From: Bowman, Gregory **On Behalf Of** EDO_Calendar Resource

Sent: Wednesday, April 13, 2011 4:56 PM

To: EDO_Calendar Resource; Melendez, Israel; Rutz, Wayne; Frazier, Alan; Bowman, Gregory; Wittick, Brian; Wertz, Trent; Correia, Richard; Gibson, Kathy; Cheok, Michael

Subject: Briefing for Commissioners Svinicki and Apostolakis on SFP Safety

When: Friday, April 29, 2011 10:00 AM-11:30 AM (GMT-05:00) Eastern Time (US & Canada).

Where: O-2B6

Update (4/13/11) – Based on discussions with Commissioner Apostolakis's office, this meeting will focus only on SFPs, and not on ISFSIs. The meeting was also extended from 60 minutes to 90 minutes.

The location for this meeting has been changed to the OWFN SCIF (O-2B6).

Please forward this appointment to the appropriate attendees from your office. I requested feedback from the Commission offices on whether to include dry storage in the topic for the briefing. I'll pass that information on as soon as I hear back.

Alan Frazier will act as the escort for the meeting.

Ibarra, Jose

From: Ibarra, Jose
Sent: Thursday, April 14, 2011 9:34 AM
To: Kauffman, John
Subject: Weekly Input

John,
My input for the week:

Addressing the FOIAs related to the Japanese Nuclear event continues to be a big effort outside the routine TA duties. This non routine work includes requesting input from staff, overall reviewing the records for exemptions and categorizing the documents. Working with the other TAs to make addressing the FOIA more consistent and efficient like generating a generic harm statement if decisional information is publicly released. Meeting with PMDA to agree on the packaging of the FOIA documents.

As part of the merit selection panel, began reviewing the applications for GG15 position in DE Regulatory Guide Development Branch.

Participated in meeting to discuss a potential risk study on spent fuel pools associated with the Japanese Nuclear Event.

Participated in Human Factors discussion on PRA related to the Japanese event.

Jose

44/492

Ibarra, Jose

From: Ramirez, Annie
Sent: Thursday, April 14, 2011 10:03 AM
To: Rivera-Lugo, Richard; Ibarra, Jose
Cc: Rini, Brett
Subject: RE: REVISE: Draft e-mail for new Kyodo FOIA

I concur with the e-mail.

Annie

From: Rivera-Lugo, Richard
Sent: Thursday, April 14, 2011 9:53 AM
To: Ibarra, Jose; Ramirez, Annie
Cc: Rini, Brett
Subject: REVISE: Draft e-mail for new Kyodo FOIA
Importance: High

Good morning TAs!

I forgot to tell you yesterday that I was going to draft a simpler e-mail with direct instructions for the new Kyodo News FOIA request, so we can send the same e-mail to our divisions like the last time. Please revise the e-mail below and let me know your comments ASAP so we can direct the staff to start working on this new request.

Thank you,
Richie

PS. Let me know what you think about putting the important steps in bold.... Too much?

DE Staff,

All RES divisions have been task with a new expedited FOIA Request from Kyodo News.

Please provide ALL documentation (This includes all "e-mails, faxes, written correspondences, meeting minutes, memos, studies, analyses") pertaining to the Japanese event **during the period of March 11, 2011 through April 11th, 2011.**

Instructions for the Kyodo FOIA request:

1. If you already submitted your records for the Associated Press (AP) and Greenpeace FOIA requests, you **DO NOT need to re-submit the records for the dates that were covered by previous requests.**
 - AP FOIA: March 11 - 16, 2011
 - Greenpeace FOIA: March 11 - 24, 2011
2. For e-mail records, provide only the communications that you have sent about the Japanese events (Sent folder). You only have to provide items from your inbox (received e-mails) if they were sent by any person, organization or agency outside of NRC.

3. The FOIA Office has requested the staff to submit all records in **hard copies, printed in a single-sided.**
4. **Make sure to mark in your records any exemptions that might apply to information that, in your opinion, should not be released to the public** (e.g. pre-decisional information, personal identifiable information, proprietary information, etc). Please follow the guidance on the "*How to Respond to a FOIA Request*" document.
5. Along with your records package, **include a sheet with your name, time spent responding to this FOIA request, and a note indicating if your submission of records is partial or final.** Packages should be dropped off at the "DE's FOIA Corner" located in front of Mike Case's office (CSB-5 A05).

More information on the active FOIA requests for RES can be found accessing the link below.
<http://www.internal.nrc.gov/RES/FOIA/index.htm>

Please use TAC# **ZF0001** to record your time in HRMS related to activities in response to a FOIA request.

Provide hard copies only of any records that meet the above criteria by 3:00 PM on Wednesday, April 20th.

If you have any questions please contact me or Jazel Parks, and we will do our best to address your concerns.

Thanks,
Richie

Richard Rivera-Lugo, EIT, MEM
Technical Assistant (Acting)
U.S. Nuclear Regulatory Commission – HQ
RES/DE
Ph. 301-251-7652
Fax 301-251-7420
Mail M.S. C5C07M
E-mail Richard.Rivera-Lugo@nrc.gov



Please consider the Environment before printing this e-mail.

Ibarra, Jose

From: Rivera-Lugo, Richard
Sent: Thursday, April 14, 2011 11:08 AM
To: Ramirez, Annie; Ibarra, Jose
Cc: Rini, Brett
Subject: RE: REVISE: Draft e-mail for new Kyodo FOIA
Attachments: Kyodo News FOIA Request.pdf

Here is the FOIA request scanned...

From: Ramirez, Annie
Sent: Thursday, April 14, 2011 10:58 AM
To: Rivera-Lugo, Richard; Ibarra, Jose
Cc: Rini, Brett
Subject: RE: REVISE: Draft e-mail for new Kyodo FOIA

I think it is a great idea! If approved I'll send it as well!

Annie

From: Rivera-Lugo, Richard
Sent: Thursday, April 14, 2011 10:53 AM
To: Ibarra, Jose; Ramirez, Annie
Cc: Rini, Brett
Subject: RE: REVISE: Draft e-mail for new Kyodo FOIA
Importance: High

Great!

Also, what do you think about adding the attached "Quick Reference to FOIA Exemptions"... I drafted this to see if the staff can finally mark their records appropriately... let me know if you have any comments on that. The idea is to provide a quick note or example of information that is covered by each exemption

If you think that it is useful, we can send it to Jazel & Heather to see if they concur with the examples provided.

Richie

PS. I will scan the FOIA request and send it to you in a few minutes so we can all include it in the e-mail for the divisions.

From: Ibarra, Jose
Sent: Thursday, April 14, 2011 10:20 AM
To: Rivera-Lugo, Richard; Ramirez, Annie
Cc: Rini, Brett
Subject: RE: REVISE: Draft e-mail for new Kyodo FOIA

Richie,

Good Work and I approve and use the e-mail for DRA . Gracias. Jose

44/494

From: Rivera-Lugo, Richard
Sent: Thursday, April 14, 2011 9:53 AM
To: Ibarra, Jose; Ramirez, Annie
Cc: Rini, Brett
Subject: REVISE: Draft e-mail for new Kyodo FOIA
Importance: High

Good morning TAs!

I forgot to tell you yesterday that I was going to draft a simpler e-mail with direct instructions for the new Kyodo News FOIA request, so we can send the same e-mail to our divisions like the last time. Please revise the e-mail below and let me know your comments ASAP so we can direct the staff to start working on this new request.

Thank you,
Richie

PS. Let me know what you think about putting the important steps in bold.... Too much?

DE Staff,

All RES divisions have been task with a new expedited FOIA Request from Kyodo News.

Please provide ALL documentation (This includes all "e-mails, faxes, written correspondences, meeting minutes, memos, studies, analyses") pertaining to the Japanese event **during the period of March 11, 2011 through April 11th, 2011.**

Instructions for the Kyodo FOIA request:

1. If you already submitted your records for the Associated Press (AP) and Greenpeace FOIA requests, you **DO NOT need to re-submit the records for the dates that were covered by previous requests.**
 - AP FOIA: March 11 - 16, 2011
 - Greenpeace FOIA: March 11 - 24, 2011
2. For e-mail records, provide only the communications that you have sent about the Japanese events (Sent folder). You only have to provide items from your inbox (received e-mails) if they were sent by any person, organization or agency outside of NRC.
3. The FOIA Office has requested the staff to submit all records in **hard copies, printed in a single-sided.**
4. **Make sure to mark in your records any exemptions that might apply to information that, in your opinion, should not be released to the public** (e.g. pre-decisional information, personal identifiable information, proprietary information, etc). Please follow the guidance on the "*How to Respond to a FOIA Request*" document.
5. Along with your records package, **include a sheet with your name, time spent responding to this FOIA request, and a note indicating if your submission of records is partial or final.** Packages should be dropped off at the "DE's FOIA Corner" located in front of Mike Case's office (CSB-5 A05).

More information on the active FOIA requests for RES can be found accessing the link below.

<http://www.internal.nrc.gov/RES/FOIA/index.htm>

Please use TAC# **ZF0001** to record your time in HRMS related to activities in response to a FOIA request.

**Provide hard copies only of any records that meet the above criteria by 3:00 PM
on Wednesday, April 20th.**

If you have any questions please contact me or Jazel Parks, and we will do our best to address your concerns.

Thanks,
Richie

Richard Rivera-Lugo, EIT, MEM
Technical Assistant (Acting)
U.S. Nuclear Regulatory Commission – HQ
RES/DE
Ph. 301-251-7652
Fax 301-251-7420
Mail M.S. C5C07M
E-mail Richard.Rivera-Lugo@nrc.gov

 Please consider the Environment before printing this e-mail.

Ibarra, Jose

From: Bensi, Michelle
Sent: Thursday, April 14, 2011 11:08 AM
To: Ibarra, Jose; Kauffman, John; Beasley, Benjamin; Rini, Brett
Subject: RE: E-Mail to OPA and NRR on Posting of Q&As on Share Point Site

I suggest the following revision:

RES Division of Risk Analysis (DRA) is working on a document containing about 150 Q&As associated with seismic hazard. The document is a revision/restructuring of a previously prepared seismic Q&A document that was circulated internally after the Japanese Earthquake. We are currently working on the updates and plan to be finished next week. We will contact OPA and NRR for posting the Q&As in the Share Point Site when we complete the revision of the Q&As. If you have any questions call Jose Ibarra, DRA TA, 301 251-7612, or Shelby Bensi, DRA, Reliability and Risk Engineer, 301 251-7570.

Thanks,
Shelby

From: Ibarra, Jose
Sent: Thursday, April 14, 2011 10:58 AM
To: Bensi, Michelle; Kauffman, John; Beasley, Benjamin; Rini, Brett
Subject: E-Mail to OPA and NRR on Posting of Q&As on Share Point Site

All,

To make sure OEDO knows that we are responding to their request for input on Q&As that are to be posted on the Share Point Site, I plan to send to Beth Hayden, OPA, and Eric Oestesle, NRR the e-mail below. Mary Muessle and Mindy Landau will be on cc:

RES Division of Risk Analysis (DRA) is working on about 150 Q&As associated with seismic hazard related Generic Issue-199. Since DRA has previously prepared Q&As due to the Japanese Nuclear Event, some of the original Q&As need to be updated. We are currently working on the updates and plan to be finished next week. We will contact OPA and NRR for posting the Q&As in the Share Point Site when we complete the Q&As. If you have any questions call Jose Ibarra, DRA TA, 301 251-7612, or Shelby Bensi, DRA, Reliability and Risk Engineer, 301 251-7570.

Thanks. Jose

44/495

Ibarra, Jose

From: Rivera-Lugo, Richard
Sent: Thursday, April 14, 2011 11:11 AM
To: Ibarra, Jose; Ramirez, Annie
Cc: Rini, Brett
Subject: RE: REVISE: Draft e-mail for new Kyodo FOIA

Perfect!

But just to make sure before I turn the document into a pdf... do any of you have suggestions or changes to the Quick Reference?

Can you take a quick look at the actual guide to verify that what I wrote is correct?

Thanks!

From: Ibarra, Jose
Sent: Thursday, April 14, 2011 11:09 AM
To: Ramirez, Annie; Rivera-Lugo, Richard
Cc: Rini, Brett
Subject: RE: REVISE: Draft e-mail for new Kyodo FOIA

Richie,

I also approve. We do not necessary need Heather or Jazel to approve but may be let them know we have prepared a quick exemption reference. As far as the staff is concerned they need to understand that this is a quick reference for their convenience and further guidance is provided in the previous e-mail attachments. Additionally, we should tell the staff if they have any questions they can go to the MD 3.1 or ask TA, Heather or Jazel. Jose

From: Ramirez, Annie
Sent: Thursday, April 14, 2011 10:58 AM
To: Rivera-Lugo, Richard; Ibarra, Jose
Cc: Rini, Brett
Subject: RE: REVISE: Draft e-mail for new Kyodo FOIA

I think it is a great idea! If approved I'll send it as well!

Annie

From: Rivera-Lugo, Richard
Sent: Thursday, April 14, 2011 10:53 AM
To: Ibarra, Jose; Ramirez, Annie
Cc: Rini, Brett
Subject: RE: REVISE: Draft e-mail for new Kyodo FOIA
Importance: High

Great!

Also, what do you think about adding the attached "Quick Reference to FOIA Exemptions"... I drafted this to see if the staff can finally mark their records appropriately... let me know if you have any comments on that. The idea is to provide a quick note or example of information that is covered by each exemption

If you think that it is useful, we can send it to Jazel & Heather to see if they concur with the examples provided.

44/496

Richie

PS. I will scan the FOIA request and send it to you in a few minutes so we can all include it in the e-mail for the divisions.

From: Ibarra, Jose
Sent: Thursday, April 14, 2011 10:20 AM
To: Rivera-Lugo, Richard; Ramirez, Annie
Cc: Rini, Brett
Subject: RE: REVISE: Draft e-mail for new Kyodo FOIA

Richie,

Good Work and I approve and use the e-mail for DRA . Gracias. Jose

From: Rivera-Lugo, Richard
Sent: Thursday, April 14, 2011 9:53 AM
To: Ibarra, Jose; Ramirez, Annie
Cc: Rini, Brett
Subject: REVISE: Draft e-mail for new Kyodo FOIA
Importance: High

Good morning TAs!

I forgot to tell you yesterday that I was going to draft a simpler e-mail with direct instructions for the new Kyodo News FOIA request, so we can send the same e-mail to our divisions like the last time. Please revise the e-mail below and let me know your comments ASAP so we can direct the staff to start working on this new request.

Thank you,
Richie

PS. Let me know what you think about putting the important steps in bold.... Too much?

DE Staff,

All RES divisions have been task with a new expedited FOIA Request from Kyodo News.

Please provide ALL documentation (This includes all "e-mails, faxes, written correspondences, meeting minutes, memos, studies, analyses") pertaining to the Japanese event **during the period of March 11, 2011 through April 11th,2011.**

Instructions for the Kyodo FOIA request:

1. If you already submitted your records for the Associated Press (AP) and Greenpeace FOIA requests, you **DO NOT** need to re-submit the records for the dates that were covered by previous requests.
 - AP FOIA: March 11 - 16, 2011
 - Greenpeace FOIA: March 11 - 24, 2011
2. For e-mail records, provide only the communications that you have sent about the Japanese events (Sent folder). You only have to provide items from your inbox (received e-mails) if they were sent by any person, organization or agency outside of NRC.

3. The FOIA Office has requested the staff to submit all records in **hard copies, printed in a single-sided.**
4. **Make sure to mark in your records any exemptions that might apply to information that, in your opinion, should not be released to the public** (e.g. pre-decisional information, personal identifiable information, proprietary information, etc). Please follow the guidance on the "*How to Respond to a FOIA Request*" document.
5. Along with your records package, **include a sheet with your name, time spent responding to this FOIA request, and a note indicating if your submission of records is partial or final.** Packages should be dropped off at the "DE's FOIA Corner" located in front of Mike Case's office (CSB-5 A05).

More information on the active FOIA requests for RES can be found accessing the link below.
<http://www.internal.nrc.gov/RES/FOIA/index.htm>

Please use TAC# **ZF0001** to record your time in HRMS related to activities in response to a FOIA request.

Provide hard copies only of any records that meet the above criteria by 3:00 PM on Wednesday, April 20th.

If you have any questions please contact me or Jazel Parks, and we will do our best to address your concerns.

Thanks,
Richie

Richard Rivera-Lugo, EIT, MEM
Technical Assistant (Acting)
U.S. Nuclear Regulatory Commission – HQ
RES/DE
Ph. 301-251-7652
Fax 301-251-7420
Mail M.S. C5C07M
E-mail Richard.Rivera-Lugo@nrc.gov



Please consider the Environment before printing this e-mail.

Ibarra, Jose

From: Rivera-Lugo, Richard
Sent: Thursday, April 14, 2011 11:33 AM
To: RES_DE
Cc: Parks, Jazel; Dempsey, Heather
Subject: ACTION: New Expedited FOIA Request from Kyodo News (Due April 20th)
Attachments: Quick Reference - FOIA Exemptions.pdf; Kyodo News FOIA Request.pdf

Importance: High

DE Staff,

All RES divisions have been task with a new expedited FOIA Request from Kyodo News.

Please provide **ALL** documentation (This includes all "e-mails, faxes, written correspondences, meeting minutes, memos, studies, analyses") pertaining to the Japanese events **during the period of March 11th through April 11th, 2011.**

Instructions for the Kyodo FOIA request:

1. If you already submitted your records for the Associated Press (AP) and Greenpeace FOIA requests, you **DO NOT** need to re-submit the records for the dates that were covered by those previous requests.
 - AP FOIA: March 11 - 16, 2011
 - Greenpeace FOIA: March 11 - 24, 2011
2. For e-mail records, **provide only the communications that you have sent addressing the Japanese events (Sent folder).** You only have to provide items from your inbox (received e-mails) if they were sent by any person, organization or agency outside of NRC.
3. The FOIA Office has requested the staff to submit all records in **hard copies, printed single-sided.**
4. **Make sure to mark in your records any exemptions that might apply to information that, in your opinion, should not be released to the public** (e.g. pre-decisional information, personal identifiable information, proprietary information, etc). Please follow the guidance on the "*How to Respond to a FOIA Request*" document. A "Quick Reference to FOIA Exemptions" is attached for your convenience.
5. Along with your records package, **include a sheet with your name, time spent responding to this FOIA request, and a note indicating if your submission of records is partial or final.** Packages should be dropped off at the "DE's FOIA Corner" located in front of Mike Case's office (CSB-5 A05).

More information on the active FOIA requests for RES can be found accessing the link below.
<http://www.internal.nrc.gov/RES/FOIA/index.htm>

Please use TAC# **ZF0001** to record your time in HRMS related to activities in response to a FOIA request.

Provide hard copies only of any records that meet the above criteria by 3:00 PM on Wednesday, April 20th.

If you have any questions please contact me or Jazel Parks, and we will do our best to address your concerns.

44/497

Thanks,
Richie

Richard Rivera-Lugo, EIT, MEM
Technical Assistant (Acting)
U.S. Nuclear Regulatory Commission – HQ
RES/DE
Ph. 301-251-7652
Fax 301-251-7420
Mail M.S. C5C07M
E-mail Richard.Rivera-Lugo@nrc.gov

 Please consider the Environment before printing this e-mail.

Ibarra, Jose

From: Rivera-Lugo, Richard
Sent: Thursday, April 14, 2011 1:26 PM
To: Rini, Brett; Ibarra, Jose; Ramirez, Annie
Subject: RE: REVISE: Draft e-mail for new Kyodo FOIA

That one in particular is referring to office location number, not phone.

From: Rini, Brett
Sent: Thursday, April 14, 2011 12:55 PM
To: Rivera-Lugo, Richard; Ibarra, Jose; Ramirez, Annie
Subject: RE: REVISE: Draft e-mail for new Kyodo FOIA

The list looks good to me. My only comment is that I don't think office numbers are considered exempted. All of our office phone numbers are posted on the public website.

From: Rivera-Lugo, Richard
Sent: Thursday, April 14, 2011 10:53 AM
To: Ibarra, Jose; Ramirez, Annie
Cc: Rini, Brett
Subject: RE: REVISE: Draft e-mail for new Kyodo FOIA
Importance: High

Great!

Also, what do you think about adding the attached "Quick Reference to FOIA Exemptions" ... I drafted this to see if the staff can finally mark their records appropriately... let me know if you have any comments on that. The idea is to provide a quick note or example of information that is covered by each exemption

If you think that it is useful, we can send it to Jazel & Heather to see if they concur with the examples provided.

Richie

PS. I will scan the FOIA request and send it to you in a few minutes so we can all include it in the e-mail for the divisions.

From: Ibarra, Jose
Sent: Thursday, April 14, 2011 10:20 AM
To: Rivera-Lugo, Richard; Ramirez, Annie
Cc: Rini, Brett
Subject: RE: REVISE: Draft e-mail for new Kyodo FOIA

Richie,

Good Work and I approve and use the e-mail for DRA . Gracias. Jose

From: Rivera-Lugo, Richard
Sent: Thursday, April 14, 2011 9:53 AM
To: Ibarra, Jose; Ramirez, Annie
Cc: Rini, Brett
Subject: REVISE: Draft e-mail for new Kyodo FOIA
Importance: High

44/498

Good morning TAs!

I forgot to tell you yesterday that I was going to draft a simpler e-mail with direct instructions for the new Kyodo News FOIA request, so we can send the same e-mail to our divisions like the last time. Please revise the e-mail below and let me know your comments ASAP so we can direct the staff to start working on this new request.

Thank you,
Richie

PS. Let me know what you think about putting the important steps in bold.... Too much?

DE Staff,

All RES divisions have been task with a new expedited FOIA Request from Kyodo News.

Please provide ALL documentation (This includes all "e-mails, faxes, written correspondences, meeting minutes, memos, studies, analyses") pertaining to the Japanese event **during the period of March 11, 2011 through April 11th, 2011.**

Instructions for the Kyodo FOIA request:

1. If you already submitted your records for the Associated Press (AP) and Greenpeace FOIA requests, you **DO NOT** need to re-submit the records for the dates that were covered by previous requests.
 - AP FOIA: March 11 - 16, 2011
 - Greenpeace FOIA: March 11 - 24, 2011
2. For e-mail records, provide only the communications that you have sent about the Japanese events (Sent folder). You only have to provide items from your inbox (received e-mails) if they were sent by any person, organization or agency outside of NRC.
3. The FOIA Office has requested the staff to submit all records in **hard copies, printed in a single-sided.**
4. **Make sure to mark in your records any exemptions that might apply to information that, in your opinion, should not be released to the public** (e.g. pre-decisional information, personal identifiable information, proprietary information, etc). Please follow the guidance on the "*How to Respond to a FOIA Request*" document.
5. Along with your records package, **include a sheet with your name, time spent responding to this FOIA request, and a note indicating if your submission of records is partial or final.** Packages should be dropped off at the "DE's FOIA Corner" located in front of Mike Case's office (CSB-5 A05).

More information on the active FOIA requests for RES can be found accessing the link below.
<http://www.internal.nrc.gov/RES/FOIA/index.htm>

Please use TAC# ZF0001 to record your time in HRMS related to activities in response to a FOIA request.

Provide hard copies only of any records that meet the above criteria by 3:00 PM on Wednesday, April 20th.

If you have any questions please contact me or Jazel Parks, and we will do our best to address your concerns.

Thanks,
Richie

Richard Rivera-Lugo, EIT, MEM
Technical Assistant (Acting)
U.S. Nuclear Regulatory Commission – HQ
RES/DE
Ph. 301-251-7652
Fax 301-251-7420
Mail M.S. C5C07M
E-mail Richard.Rivera-Lugo@nrc.gov

 Please consider the Environment before printing this e-mail.

From: EUCI Events
To: Correia, Richard
Subject: Nuclear Power Plant Operations Course in July
Date: Thursday, April 14, 2011 1:13:53 PM

[If you are having trouble viewing this email view it on our website here](#)

Nuclear Power Plant Operations

July 11-12, 2011 :: Chicago, IL

Overview

This nuclear power plant (NPP) operations course provides attendees with a clear understanding of how these powerful plants function and produce electricity. The course describes how plants are built, how a nuclear startup is conducted, and how the plant is moved from cold iron to 100 percent power. Plant staffing and full power operations will be addressed, including boration/dilution, fuel rods, and electrical load. Functions of components of the balance-of-plant (outside of the nuclear island) will be described (turbines, generators, and cooling systems). The inherent stability and safety systems of nuclear plants will be covered in detail. Procedures for conducting a refueling outage and discussion of major outage tasks, including refueling, CEA change-outs, component rebuilds, and surveillance testing will be conducted. **Participants will complete the course with full comprehension of and appreciation for the functions of the NPP and the production of electricity in the nuclear environment.**

[PDF Brochure](#) | [Pricing and Registration](#)

Topics Include

- The fission process, plant startups, and how reactors work
- How plants are staffed and what positions are required in a nuclear plant
- Thermal cycle, heat transfer, and the components of a nuclear plant
- How electricity is produced in a nuclear power plant
- The intricacies of plant safety systems
- What is required in managing refuel outages and how nuclear fuel reloads are accomplished

[Full Agenda](#)

Instructed By

Burton A. Grabo, Nuclear Industry Consultant

Mr. Grabo has over 30 years of experience in the nuclear power industry and began his career as a lead instructor and senior mechanical trainer in the nuclear Navy. He began working in the commercial nuclear industry as a reactor operator and radiation protection worker with Arkansas Nuclear One. Burt has served in many capacities with the Palo Verde Nuclear Generating Station (PVNGS), including as Lead Senior Instructor and Section Leader for Nuclear Training, Nuclear Regulatory Affairs Section Leader, and Nuclear Assurance Operations Section Leader. He also created the maintenance intern program at PVNGS and served as the special project manager for the Nuclear Fuel Management department. During his career, Burt has held reactor and senior reactor operator licenses (including fuel handling) and has written numerous training curriculums and presented lectures in nuclear power plant operations. He holds a Bachelor of Arts degree from Ottawa University and completed nuclear engineering training at Memphis and Arizona State Universities.

Energize Weekly

Sign up to get our "Energize Weekly" newsletter and keep up with the latest events in the

Testimonials from Past Attendees

"This course provided an excellent overview of nuclear power plant design, operation, and safety considerations."

-President, EJCON Corp.

"Fantastic – did not speak over our head, was able to relay info in comprehensive examples. My concerns that the class would exceed my comprehension level diminished right away."

-Chief estimator, Graycor

"Very engaging and humorous. Knows his stuff and makes students feel comfortable."

-Engineers, IRS Appeals

"Great crash course for non-engineers!"

-Senior recruiter, The Spear Group, Inc.

Browse All Events By Category

- [Generation](#)
- [Natural Gas](#)
- [Nuclear](#)
- [Coal](#)
- [Future/Alternative Generation](#)
- [Solar](#)
- [Biomass](#)
- [Hydro](#)
- [Energy Storage](#)
- [Transmission](#)
- [Distribution](#)
- [Security/Safety](#)
- [Metering Technologies](#)
- [Demand Response, Energy Efficiency](#)
- [Environmental and Emissions](#)
- [Markets and Trading](#)
- [Risk Management](#)
- [Rates, Finance and](#)

44/499

energy industry. Energize Weekly also contains a new conference presentation each week on a relevant industry topic.

[Sign Up Now](#)

- [Accounting](#)
- [Billing/Customer Service/Collections](#)
- [Communications/Marketing](#)
- [Utility Business and Management](#)
- [Human Resources](#)
- [Regulatory, Policy and Legal Issues](#)

Copyright © EUCI

If you no longer wish to get these emails, you may delete your name from our distribution lists [here](#).

Ibarra, Jose

REL

From: Ibarra, Jose
Sent: Thursday, April 14, 2011 3:40 PM
To: Hasselberg, Rick
Subject: RE: Lessons Learned

Rick,
Here is the table that I sent twice at the request of RES front office staff. The information was collected by me as the TA for Division of Risk Analysis. Where that information was sent is unknown to me. Additionally, my branch chief sent similar information at least once. Many RES staff also contacted the Op Center and use other communications methods to make themselves available. The table does not list all the experience that I mentioned in my e-mail. This would be too much information for one table. Thanks. Jose

From: Hasselberg, Rick
Sent: Thursday, April 14, 2011 3:26 PM
To: Ibarra, Jose
Cc: Alter, Peter
Subject: RE: Lessons Learned

Thanks, Jose. Where can I find those lists? I'd like to see that I don't make that mistake again.

From: Ibarra, Jose
Sent: Thursday, April 14, 2011 3:12 PM
To: Hasselberg, Rick; Alter, Peter
Cc: Rini, Brett; Correia, Richard; Coe, Doug
Subject: Lessons Learned

Rick and Peter,

This my take on the lessons learned for the IRC (Op Center) for the Japanese Nuclear Event monitoring.

The need for volunteers to man the IRC (Ops Center) was not well managed. RES provided many times over the course of three weeks a list of volunteers and yet only a few were called to help out. These lists included the staff specialty and identified the staff volunteering to go to Japan. Besides specialties, RES has a wealth of staff with experience in operations, systems designs, reactor designs, spent fuel pool assessments, Incident Investigation Team and Augmented Inspection Team, special inspections, routine plant inspection,, Ops Center experience, licensee plant experience, international working experience, multilingual, diplomatic experience, familiar with the Japanese culture, and many other experience that is usually associated with NRR, NRO, and OIP staff. Additionally, many of the RES volunteers have decades of NRC experience allowing them to know who and where to reach to in the NRC for needed expertise. All these experiences would have helped the IRC in their assessments.

Jose

44/500

From: Ibarra, Jose
To: RES_DRA
Subject: Kyodo News FOIA 2011-0184
Date: Thursday, April 14, 2011 4:15:51 PM
Attachments: Quick Reference - FOIA Exemptions.docx
Kyodo News FOIA Request.pdf

DRA Staff,

Here we go again. All RES divisions have been task with a new expedited FOIA Request from Kyodo News. Most and if not all of this request applies only to the technical staff since what is requested are technical records.

Please provide ALL documentation (This includes all "e-mails, faxes, written correspondences, meeting minutes, memos, studies, analyses") pertaining to the Japanese event **during the period of March 11, 2011 through April 11th, 2011.**

Instructions for the Kyodo FOIA request:

1. If you already submitted your records for the Associated Press (AP) and Greenpeace FOIA requests, you **DO NOT need to re-submit the records for the dates that were covered by previous requests.**
 - AP FOIA: March 11 - 16, 2011
 - Greenpeace FOIA: March 11 - 24, 2011
2. For e-mail records, provide only the communications that you have sent about the Japanese events (Sent folder). You only have to provide items from your inbox (received e-mails) if they were sent by any person, organization or agency outside of NRC.
3. The FOIA Office has requested the staff to submit all records in **hard copies, printed in a single-sided.**
4. **Make sure to mark in your records any exemptions that might apply to information that, in your opinion, should not be released to the public** (e.g. pre-decisional information, personal identifiable information, proprietary information, etc). Please follow the guidance on the "How to Respond to a FOIA Request" document.
5. Along with your records package, **include a sheet with your name, time spent responding to this FOIA request, and a note indicating if your submission of records is partial or final.**

More information on the active FOIA requests for RES can be found accessing the link below.

<http://www.internal.nrc.gov/RES/FOIA/index.htm>

Please use TAC# **ZF0001** to record your time in HRMS related to activities in response to a FOIA request.

44/501

Provide hard copies only of any records that meet the above criteria by 3:00 PM on Wednesday, April 20th.

If you have any questions please contact me or Jazel Parks, and we will do our best to address your concerns.

Attached is the FOIA request and a quick reference for your convenience on the exemptions.

Thanks,
Jose

Attachment Quick Reference - FOIA Exemptions.docx (16165 Bytes) cannot be converted to PDF format.

FOIA Resource

From: uid no body [nobody@www.nrc.gov]
Sent: Monday, April 11, 2011 5:39 PM
To: FOIA Resource
Subject: WWW Form Submission

FOIAPA REQUEST
Case No.: 2011 0184
Date Rec'd: 4-11-11
Specialist: Blawie
Related Case: _____

Below is the result of your feedback form. It was submitted by
() on Monday, April 11, 2011 at 17:38:49

FirstName: Takao

LastName: Ikeuchi

Company/Affiliation: Kyodo News

Address1: 529 14th Street NW Suite 400 National Press Bldg.

Address2:

City: Washington

State: DC

Zip: 20045

Country: United_States

Country-Other:

Email: ikeuchi.takao@kyodonews.jp

Phone: 2023475767

Desc: I request copies of any and all documents regarding nuclear crisis in Japan after March 10th. Documents include e-mails, faxes written correspondences, meeting minutes, memos, studies, analyses.

FeeCategory: NewsMedia

MediaType: Kyodo News

MediaType_TVRadio: on

FeeCategory_Description: News agency (wire)

Expedite_ImminentThreat: on

Expedite_ImminentThreatText: Because this nuclear crisis is ongoing public concern, and information is urgently required to inform, I request that you consider this an expedited request. I certify that I am a full time employee for Kyodo News. leading news wire in Japan. Our news is carried by more than 500 outlets world wide.

Expedite_UrgencyToInformText:

Waiver_Purpose:

Waiver_ExtentToExtractAnalyze:

Waiver_SpecificActivityQuals:

Waiver_ImpactPublicUnderstanding:

Waiver_NatureOfPublic:

Waiver_MeansOfDissemination:

Waiver_FreeToPublicOrFee:

Waiver_PrivateCommericalInterest:

Subject: Discuss Roles and Responsibilities for Japan transition - POCs
Location: OPS Center

Start: Thu 4/14/2011 11:00 AM
End: Thu 4/14/2011 12:00 PM

Recurrence: (none)

Meeting Status: Accepted

Organizer: Salus, Amy
Required Attendees: Evans, Michele; Virgilio, Martin; Weber, Michael; Case, Michael; Skeen, David; Harrington, Holly; Emche, Danielle; Weaver, Doug; Deegan, George; Dudek, Michael; McDermott, Brian; Morris, Scott; Marshall, Jane; Ciocco, Jeff; Gibson, Kathy; Hiland, Patrick; Lewis, Robert; Kevern, Thomas; Bloom, Steven

When: Thursday, April 14, 2011 11:00 AM-12:00 PM (GMT-05:00) Eastern Time (US & Canada).
Where: OPS Center

Note: The GMT offset above does not reflect daylight saving time adjustments.

~~*~*~*~*~*~*~*~*

POC Michael Dudek
Posted by ASalus

44/502

From: Virgilio, Martin
Sent: Friday, April 15, 2011 2:36 PM
To: Virgilio, Martin
Subject: Return to Tokyo
Attachments: PARTIAL AD Termination Memo MarkupForHoward pmt comments apr 5.docx

From: LIA08 Hoc
Sent: Monday, April 11, 2011 10:56 PM
To: Virgilio, Martin
Cc: Wiggins, Jim
Subject: FW:

Sir,

This appears to be the Tokyo re-entry document with PMT comments.

V/R,

Clyde Ragland
Liaison Team Coordinator
US Nuclear Regulatory Commission
Email: lia08.hoc@nrc.gov
Desk Ph: 301-816-5185

From: Hoc, PMT12
Sent: Monday, April 11, 2011 7:46 PM
To: LIA08 Hoc
Subject: FW:

Is this what you were looking for?

Stacey

PMT-PAAD

From: Hoc, PMT12
Sent: Friday, April 08, 2011 7:29 PM
To: 'Holahan, Eugene V SES PACOM, J91'
Subject:

Vince

Here's the document we commented on for the DOS/Ambassador.

Sandi

44/503

PMT-PAAD

UNCLASSIFIED MEMORANDUM (PMT/RST/ET Comments, April 5)

Draft Memo: US Ambassador /Japan to US State Department

(KEY: BLUE = EMBASSY STAFF COMMENTS; PURPLE = JAPAN TEAM COMMENTS; RED = PMT/RST/ET COMMENTS)

RECOMMENDATION

I recommend that Authorized Departure for Embassy Tokyo, FSI-Yokohama and the Consulate in Nagoya not be extended beyond the initial 30 days and that all evacuated family members be allowed to return beginning April 15. If you concur, I would appreciate your notifying us soonest so our family members can make travel arrangements needed to arrive in Tokyo in time for children to begin school by Monday, April 18.

BACKGROUND

Following the earthquake and tsunami of March 11, 2011, and a deteriorating situation at the Fukushima Daiichi Nuclear Power Plant, you authorized voluntary departure of eligible family members of U.S. Embassy staff in Tokyo on March 16. At that time the condition of the damaged Fukushima reactors was largely unknown, and there was a serious possibility that a serious significant release of radioactive material could occur. The spreading radioactive contamination could present have presented a health risk to residents of the Tokyo area. In addition, in the intervening 5 days, Post experienced over 280 earthquakes at 5.0 or higher intensity non the US scale; public transportation in Tokyo had been seriously disrupted; and, there were rolling power blackouts and shortages of food and gasoline. Acting out of an "abundance of caution," you authorized the voluntary departure of Embassy family members (EFMs). That was the correct decision at that time. Anxiety levels among family members had peaked with such pervasive feelings of insecurity that Post supported the decision and truly appreciates the continued support you provided us during this time.

Formatted: Strikethrough

Formatted: Strikethrough

Formatted: Strikethrough

In the 3 weeks since, life in and around Tokyo has returned to a "new normal." We have gained a lot of information about the status of the Fukushima plant and our NRC and DOE colleagues now meet regularly with the plant's owner, TEPCO, and the GOJ's nuclear regulators. We have gathered a lot of data about radiation levels around Tokyo and at the Embassy itself. We feel confident we understand the situation much better than we did on March 16. Although the situation at Fukushima is still critical serious, the reactors' condition has become relatively static. Nuclear fuel continues to cool, and radiation discharges have only minimally impacted Tokyo. In my opinion and the collective opinion of the experts currently at Post working on this issue, any threat Fukushima now poses to Tokyo has declined to where I now feel safe recommending our family members return.

FUKUSHIMA NUCLEAR SITUATION

Nuclear experts from the NRC project that the Fukushima reactor situation ~~will most likely could~~ result in periodic, slightly elevated ~~but and not dangerous~~ levels of atmospheric radiation in the Tokyo and Yokohama areas and will have no appreciable effect on Nagoya. This judgment is based on Tokyo's being over 150-miles from the Fukushima reactors (the ~~NEC-USG~~, based on the NRC assessments, have defined the "exclusion area" at risk as being recommended evacuation of US citizens within a 50 mile radius ~~of of Fukushima~~) and the much reduced level of energy of the reactors' fuel after more than a month of ~~continuous~~ cooling following the reactors' immediate shut-down when the earthquake hit on March 11.

Formatted: Strikethrough

Formatted: Strikethrough

Formatted: Strikethrough

In addition, we now know, based on actual radiation measurements taken on the roof of the Embassy from March 24 to today, that the amount of radioactive substances that have reached Tokyo is very low, almost immeasurable. There was, however, a small increase in the measurements ~~on about around~~ March 24, although at a very low level. Since then, while the measurements have varied daily, they have steadily decreased and are now almost half of the small increase seen on that day. With that one exception, the monitoring device on the roof of the Embassy has only read extremely minor changes that are so similar to normal variations, that they are indistinguishable from normal background readings that might be made on any given day when there has been no radioactive release. This finding ~~is~~ reflects the substantial distance between Tokyo and the damaged reactors.

~~It is theoretically possible to come up with a hypothetical, "worst case" option that posits another 9.0+ quake that knocks down the reactors' buildings and exposes the fuel while at the same time the prevailing winds shift into the Tokyo direction for many days resulting in higher levels of radiation in the Tokyo area. The condition of the reactors at Fukushima Daiichi has been relatively unchanged since (Japan team supplied date). It is, however, an evolving situation at the plant and much work remains to achieve a long-term stable condition. As such, the experts here, however, consider have determined this such an event it to be extremely unlikely and that there is a low likelihood of a significant release of radioactive material that could reach outside the 50 mile evacuation zone. Therefore, any further unexpected -plant event even so would result in a radiation level that could be effectively managed without resorting to an evacuation of Tokyo. The availability of many sources of environmental monitoring information would provide hours to days of advance warning before significantly increasing radiation levels could reach Tokyo.~~

Formatted: Strikethrough

Formatted: Strikethrough

HEALTH

The health experts here do not see a health risk from present atmospheric radiation in the Tokyo area at this time. Even if ~~the "worst pessimistic case" described above occurs~~ conditions at the Fukushima reactors significantly degrade, our health team believes that the only expected risk would be to pregnant women and small children and that there will be time to implement protective measures. ~~(PMT commented on segregating populations for special protective measures such as sheltering. The intent of the statement was to address ingestion, and the Japan Team also discussed this in a prior meeting with Embassy health officials, but Embassy staff decided to keep statements).~~ We are certain that any resulting exposure in the Tokyo area will be chiefly due to small quantities of Iodine-131. This is a short-half life radioactive isotope for which sheltering in place and the use of bottled water for limited periods of time should be sufficient to avoid health risks in all age groups and in pregnancy. Ongoing, competent local monitoring of food and water supplies will inform consumer safety.

Formatted: Strikethrough

There was one day when the GOJ announced the levels of Iodine-131 in ~~drinking water~~ the intake source for the metropolitan water system exceeded the level safe for pregnant women and infants, though tap water readings remained within safe levels. The GOJ recommended infants drink only bottled water. Our health professionals agreed with the GOJ's assessment and recommendation. Since that date, however, there has been general agreement that Tokyo's water supply has been safe. We at the embassy are also testing our water supply periodically. So far there has been no noted risk of radiation. As a contingency, we have in stock 25,000 bottles of water and ready access to more if necessary.

The final potential health risk is contaminated food. The GOJ regularly tests all agricultural production from the affected areas with FDA and USDA assistance. We believe that ~~tainted~~ contaminated food will effectively be kept off the market based on our knowledge of the GOJ's inspection regime, Japanese food standards, and the actions of the food distributors. The Fukushima area is not a major food production region, except for rice that is not now being harvested. The skeptical Japanese consumer is also avoiding any hint of a Fukushima-origin product, and retailers are refusing to stock anything from that region even if tested and found to be radiation free.

Formatted: Strikethrough

All these issues are discussed in depth in the Mission's web pages. In addition, we are planning a series of health-related discussion for our family members when they return to make them better able to manage any risk that may surface

EARTHQUAKES/AFTERSHOCKS

The number of earthquakes and aftershocks 5.0 and above, rapidly and substantially decreased since that tragic day March 11. From March 11 to the Authorized Departure date of March 16, we experienced 288 serious earthquakes. That frequency is now down to one or two per day and is expected to continue declining. Last week, OBO sent a team of engineers to survey our

facilities, and they concluded that all our buildings are structurally sound and reacted to the severe March 11 quake as designed.

EDUCATION

Our families have many issues of concern. The most important, in addition to their health and safety, is their children's education. As of Monday, April 4, all international schools have reopened for students and are operating normally. This means that our children are not with their classmates, in an instructor-led setting, or at a familiar school. In addition, the resources from these international schools to support distance education of our children will not extend past April 15. The school headmasters notified us that students failing to return by April 18 are at risk of not being allowed to complete the school year. This is an especially large worry for high school seniors who may not graduate.

TOKYO LIFE

All the traffic restrictions for the major highways, including Tohoku Highway and Banetsu Highway, have been lifted for all vehicle type of vehicles, although there are still some closed roads in the tsunami affected areas. In Tokyo there are no longer restrictions on gas purchases, the Tokyo subway system is operating on an "almost normal" schedule as are most major intercity railways.

Most supermarkets in the Tokyo area are operating normal hours, although there may be some service interruptions due to scheduled power blackouts, especially in the Yokohama area. Current shipments of milk and milk products to the Tokyo area are at around 50% of the level prior to the earthquake and do not include milk from prefectures near the stricken nuclear plant.

Tokyo Disney Resort will partially resume operations April 6. Disney Land and Disney Sea will have abbreviated hours, open until 6 pm, to save electricity. The theme park operator will install large gas-powered generators in preparation for potential electricity shortfalls.

The Japanese baseball season restarted this week with local favorite Yakult Swallows hosting the Hiroshima Carp. The March Grand Sumo Tournament was canceled, but the next Grand Tournament in May remains scheduled. Popular areas once vibrant with activity are somewhat muted (though still flourish) as the Japanese are avoiding celebrations or ostentatious living in light of the many thousands of people still suffering from the tsunami's destruction.

LOOKING AHEAD

Any nation would struggle with the overwhelming magnitude of this crisis; yet, Japan leads an impressive response network augmented by our own forces and staff. I frequently meet with the industry experts, GOJ officials, and our emergency response teams. We realize that this crisis will not be solved quickly and are shifting resources for the long-term management of the situation. Because the Tokyo, Yokohama and Nagoya areas continue to be, and likely will remain, safe from ill-effects, I strongly urge you to terminate Authorized Departure, allowing families to reunite, returning children to school, and helping us return to our own "new normal" operations.

From: Sheron, Brian
To: Bonaccorso, Amy; Case, Michael; Coe, Doug; Correia, Richard; Dion, Jeanne; Gibson, Kathy; Richards, Stuart; Rini, Brett; Sangirino, Donna-Marie; Scott, Michael; Uhle, Jennifer; Valentin, Andrea
Subject: FW: Two late TNT additions
Date: Friday, April 15, 2011 7:15:44 AM

From: Brenner, Eliot
Sent: Thursday, April 14, 2011 8:30 PM
To: Brenner, Eliot
Subject: Two late TNT additions

FUKUSHIMA-DRIVEN US REACTOR UPGRADES – The New York Times reports: The Tennessee Valley Authority said Thursday it was considering millions of dollars of improvements to protect its six nuclear reactors from earthquakes and floods. It is the first American reactor operator to announce safety changes that it is weighing since an earthquake and tsunami set off a nuclear crisis at the Fukushima Daiichi plant in Japan last month. Other operators have said publicly that they might have to make changes, but they have avoided saying what those were.

The T.V.A. issued a fact sheet saying that it was considering reducing the amount of fuel in its spent fuel pools by transferring older fuel to passively cooled “dry casks” and adding additional backup diesel generators. It also listed three changes that are less commonly discussed: improving electrical switchyards to make them more resistant to earthquakes, adding small generators to recharge cellphone batteries and keep the lights on, and reinforcing the pipes that provide cooling water to spent fuel pools.

<http://www.nytimes.com/2011/04/15/science/earth/15nuclear.html>

SONGS Plume Phase and State Ingestion Pathway Exercise (Irvine, CA) – OPA staffed a press room for real media today at the ingestion pathway exercise in anticipation of possible press attendance. FEMA, SONGS and DHS Public Affairs also staffed the exercise. 29 media outlets attended the Tuesday plume phase exercise at the SONGS JIC. Today, no media showed up at the hotel during the exercise as they were encouraged on Tuesday that the Friday meeting would be more worthwhile. We expect a large turnout tomorrow at the public meeting in San Juan Capistrano and will have OPA on site to manage press.

44/504

From: [Barnes, Valerie](#)
To: [Coe, Doug](#); [Correia, Richard](#)
Subject: FW: Pics of the life of Fukushima workers
Date: Friday, April 15, 2011 1:48:49 PM

You may find these interesting, too.

From: Barnes, Valerie
Sent: Friday, April 15, 2011 1:48 PM
To: Desaulniers, David; Peters, Sean
Subject: Pics of the life of Fukushima workers

<http://www.tokyohive.com/2011/04/friday-illustrates-the-life-of-workers-at-fukushima-dai-ichi/>

44/505

Coe, Doug

From: Correia, Richard
Sent: Monday, April 18, 2011 11:45 AM
To: Drouin, Mary; Demoss, Gary; Coe, Doug
Subject: RE: [WARNING: MESSAGE ENCRYPTED]Fwd: Re: RE: Fukushima Impact Project Team

Thanks Mary for the information. I will certainly forward it to the Ops center RST.

Thanks again.

Rich

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

-----Original Message-----

From: Drouin, Mary
Sent: Monday, April 18, 2011 11:02 AM
To: Correia, Richard; Demoss, Gary; Coe, Doug
Subject: FW: [WARNING: MESSAGE ENCRYPTED]Fwd: Re: RE: Fukushima Impact Project Team

Rich.

Kojima-san is a member of the ASME/ANS Joint Committee on Nuclear Risk Management (where I am the NRC rep). JCNRM has formed a small project team to look at the Fukushima event. Anyway, Kojima-san sent in this information our project team, NRC probably has, but if not, I thought ops center may want to have.

Tks, mary

-----Original Message-----

From: Karl Fleming [<mailto:fleming@ti-sd.com>]
Sent: Monday, April 18, 2011 10:48 AM
To: 'LEVINSON Stanley (AREVA)'; Gene Hughes; 'Henneke, Dennis (GE Power & Water)'; 'Karl Fleming'; 'Pamela Nelson'; 'Grantom, Carl'; RJBudnitz@lbl.gov; Drouin, Mary; ravindramalathi@cox.net; Erlertld@aol.com; ennisk@asme.org; martinezo@asme.org; 'Doug True'
Cc: Ken Canavan
Subject: [WARNING: MESSAGE ENCRYPTED]Fwd: Re: RE: Fukushima Impact Project Team

Hi:

Here is some info from Kojima-san regarding details of TEPCOs recovery plan.

Karl

>From: Karl Fleming <fleming@ti-sd.com>
>Subject: Fwd: Re: RE: Fukushima Impact Project Team
>
>

YY/506

>>X-Final-Delivery: alpha.postal.redwire.net v8.6.11; msgid
>>201104-601308-3242135
>>Delivered-To: fleming@redwire.net
>>Delivered-To: fleming@ti-sd.com
>>X-Originating-IP: 202.216.231.141
>>From: "Kojima" <ttn4uyt24i@mx9.ttcn.ne.jp>
>>To: "Karl Fleming" <fleming@ti-sd.com>
>>Subject: Re: RE: Fukushima Impact Project Team
>>Date: Mon, 18 Apr 2011 09:58:38 +0900
>>X-Mailer: Microsoft Windows Mail 6.0.6002.18197
>>
>>Dear Fleming-san
>>
>>Yesterday, TEPCO presented the attached recovery plan for Fukushima
>>Daiichi event.
>>Please see it. How do you think of this plan?
>>
>>Kojima-san
>>
>>----- Original Message ----- From: "Karl Fleming" <fleming@ti-sd.com>
>>To: <ttn4uyt24i@mx9.ttcn.ne.jp>
>>Sent: Wednesday, April 13, 2011 3:15 AM
>>Subject: Fwd: RE: Fukushima Impact Project Team
>>
>>
>>>Dear Kojima-san:
>>>
>>>Here are initial inputs on Fukushima task force who is talking on the
>>>phone today.
>>>
>>>Best regards:
>>>
>>>Fleming-san
>>>
>>>>X-AntiVirus: Skipped; prescanned by simscan
>>>>X-Final-Delivery: delta.postal.redwire.net v8.6.11; msgid
>>>>201104-412488-14055022
>>>>X-Spam-Checker-Version: SpamAssassin 3.2.3 (2007-08-08) on
>>>> delta.postal.redwire.net
>>>>X-Spam-Level: **
>>>>X-Spam-Status: No, score=2.6 required=14.0 tests=AWL,FH_DATE_PAST_20XX
>>>> shortcircuit=no autolearn=disabled version=3.2.3
>>>>Delivered-To: fleming@redwire.net
>>>>Delivered-To: fleming@ti-sd.com
>>>>X-Originating-IP: 67.192.241.164
>>>>/m:
>>>>X-Virus-Scanned: OK
>>>>From: "Gene Hughes" <eah@etranco.com>
>>>>To: "'Pamela Nelson'" <pnelson_007@yahoo.com>,
>>>> "'Grantom, Carl'" <crgrantom@STPEGS.COM>, <Stanley.Levinson@areva.com>,
>>>> <RJBudnitz@lbl.gov>, <Mary.Drouin@nrc.gov>, <ravindramalathi@cox.net>,
>>>> <dennis.henneke@ge.com>, <Erlerltd@aol.com>, <ennisk@asme.org>,
>>>> <martinezo@asme.org>, "'Doug True'" <detrue@erineng.com>,
>>>> "'Karl Fleming'" <fleming@ti-sd.com>
>>>>Subject: RE: Fukushima Impact Project Team
>>>>Date: Tue, 12 Apr 2011 10:47:56 -0700
>>>>X-Mailer: Microsoft Office Outlook 12.0

>>>>Thread-Index: Acv5LvdiymRB/01bT3Gn8kT76vJfUgACKmww
>>>>
>>>>Attached is the current version of the draft Charter for our call.
>>>>It may not have your comments incorporated so please be prepared to
>>>>help me revise it.
>>>>
>>>>Also in one place some but not all inputs received.
>>>>
>>>>The call in number is 866-359-4571, pass code 2125917075.
>>>>
>>>>I somehow beat the leader code requirement and am on the line
>>>>holding until we start. Should be OK.
>>>>
>>>>
>>>>
>>
>>
>>
>>
>>
>>



From: Sheron, Brian
Sent: Monday, April 18, 2011 7:52 AM
To: Weber, Michael; Virgilio, Martin
Subject: Fw: Useful presentation from <http://allthingsnuclear.org> of April 14, and a SUGGESTION for improving our BWRs
Attachments: ATT00001..gif; ATT00002..gif

Interesting suggestion. I forwarded it to Charlie.

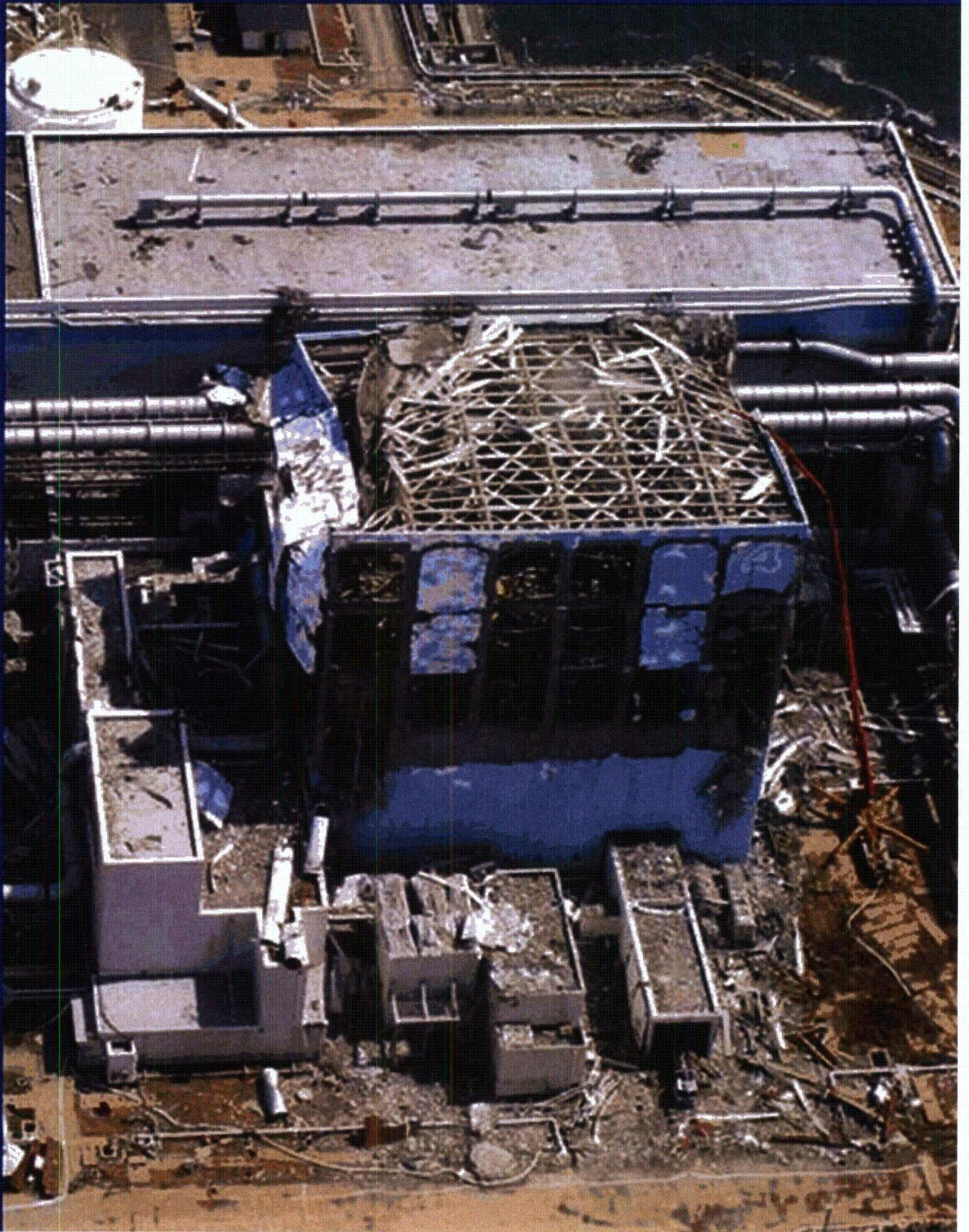
From: Richard L Garwin <rlg2@us.ibm.com>
To: Larzelere, Alex <alex.larzelere@nuclear.energy.gov>
Cc: Caponiti, Alice <Alice.Caponiti@nuclear.energy.gov>; Busby, Jeremy T <busbyjt@ornl.gov>; DL-NITsolutions <DL-NITsolutions@nnsa.doe.gov>; Schneider, Steve <Steve.Schneider@em.doe.gov>
Sent: Sun Apr 17 16:24:44 2011
Subject: Useful presentation from <http://allthingsnuclear.org> of April 14, and a SUGGESTION for improving our BWRs

Dear Colleagues,

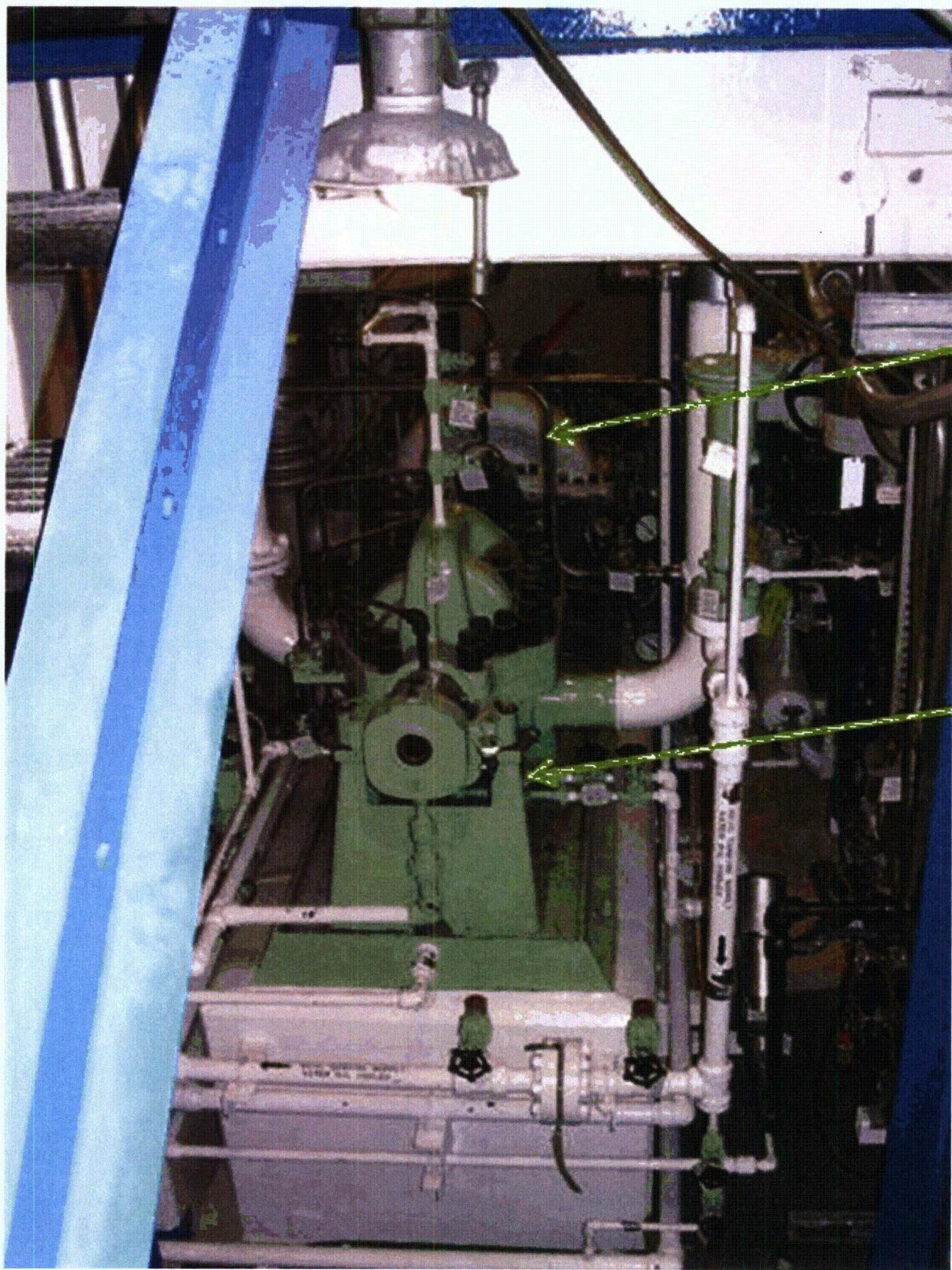
<http://allthingsnuclear.org> of April 14 has a very useful presentation of the Fukushima Dai-ichi problem.

I attach the first slide and also a detail of the steam-driven "isolation turbine and pump," and provide also a SUGGESTION by Bill Press.

44/507



Reactor Core Isolation Co



Bill Press (William H. Press, University of Texas at Austin, and LANL) asks why the RCIC turbine/pump does not have a "magneto" on the shaft, like that on a piston-driven aircraft engine, so that whenever the pump is running there is electrical power generated for the RCIC valves and other emergency loads. This might well be used to charge the batteries, too, and operate the control room indicators and lights.

This seems to me an eminently practical suggestion, which I am passing on for communication to NE and NRC.

Dick Garwin

Coe, Doug

From: Rupinta, Shane
Sent: Monday, April 18, 2011 12:04 PM
To: RES Distribution
Subject: FYI: Encore Staff Presentation hosted by Michael Scott

For those that missed it, Michael Scott, Deputy Director of DSA, will be giving an encore presentation to RES staff on his travels and experiences while assisting in the Japanese Tsunami/Nuclear disaster from 10:30 – 12pm on Wednesday, April 20 in Room 3C-19.

Thanks,
Shane Rupinta
Branch Chief (Acting)
RES/PMDA/ITIB
(O) 301.251.7992

YY/508

Stutzke, Martin

From: Stutzke, Martin
Sent: Monday, April 18, 2011 1:22 PM
To: Beasley, Benjamin; Ake, Jon
Cc: Kauffman, John
Subject: RE: Follow-up to March 22nd meeting

Maybe I'm a little late in responding, but the site amplification factors were obtained from EPRI, "Probabilistic Seismic hazard Evaluations at Nuclear power Plant Sites in the Central and Eastern United states: Resolution of the Charleston Earthquake Issue," NP-6395-D, April 1989. This report is EPRI proprietary (according to the EPRI website).

That being said, Indian Point is a rock site, so no site-specific amp factors are need to adjust the USGS seismic hazard curves.

Marty

From: Beasley, Benjamin
Sent: Friday, April 15, 2011 7:53 AM
To: Ake, Jon; Stutzke, Martin
Cc: Kauffman, John
Subject: RE: Follow-up to March 22nd meeting

Are the site amplification functions proprietary? Is it much effort to provide them for the New York plants?

Ben

From: Ake, Jon
Sent: Thursday, April 14, 2011 10:51 PM
To: Beasley, Benjamin; Stutzke, Martin
Cc: Kauffman, John
Subject: RE: Follow-up to March 22nd meeting

Ben-
almost everything, the hazard information is not explicitly in the appendices. I used the USGS seismic hazard code (reference is in the S/RA report) and the site amplification functions were based on info in the 1989 EPRI-SOG study.
Jon

From: Beasley, Benjamin
Sent: Thursday, April 14, 2011 2:48 PM
To: Stutzke, Martin; Ake, Jon
Cc: Kauffman, John
Subject: FW: Follow-up to March 22nd meeting

Marty and Jon,

New York is asking for:

"The data that the NRC considered as part of its GI-199 review. Also, please identify who produced that data."

441509

Is it true that everything needed to reproduce our S/RA results is contained in the Appendices (if you know what you are doing)?

Ben

From: Boska, John
Sent: Thursday, April 14, 2011 2:39 PM
To: Beasley, Benjamin; Kauffman, John
Subject: FW: Follow-up to March 22nd meeting

I'm trying to answer the request from Peterson below.

John Boska
Indian Point Project Manager, NRR/DORL
U.S. Nuclear Regulatory Commission
301-415-2901
email: john.boska@nrc.gov

From: Tift, Doug
Sent: Wednesday, April 13, 2011 8:59 AM
To: Boska, John
Cc: Gray, Mel; McNamara, Nancy; Salgado, Nancy
Subject: FW: Follow-up to March 22nd meeting

John,

As follow up to the March 22 meeting between NY and the NRC, the state is still looking for additional information (see below). To ensure we are all on the same page, I've attached our previous two responses to the state.

Are the below requests in alignment with what you understood at the meeting? Will you take the lead in getting responses for the below information?

Let me know if you need any additional clarification from the state on any of the below items.

-Doug

From: Alyse L. Peterson [<mailto:alp@nyserda.org>]
Sent: Wednesday, April 13, 2011 8:43 AM
To: Tift, Doug; McNamara, Nancy
Subject: Follow-up to March 22nd meeting

Good morning Doug and Nancy,

During the March 22, 2011 meeting between Lieutenant Governor Duffy and NRC Senior Staff, NRC agreed to provide certain information related to seismic concerns. We have received two transmittals from NRC, both dated March 28, 2011, but they do not provide a complete response to our request. Please provide:

-- Specific information on seismic hazards as they relate to spent fuel pools. In particular, were the spent fuel pools part of the review in GI-199? If not, were they part of any other review for seismic risk?

- Clarification on the threshold for requiring changes at a facility because of seismic risk.
- Specific information on seismic hazards as they relate to underground infrastructure, such as diesel fuel tanks.
- The data that the NRC considered as part of its GI-199 review. Also, please identify who produced that data.

Thank you in advance for your assistance.

Alyse Peterson

Coe, Doug

From: Dozier, Jerry
Sent: Monday, April 18, 2011 1:55 PM
To: Aissa, Mourad; Algama, Don; Alter, Peter; Armstrong, Kenneth; Bajorek, Stephen; Beasley, Benjamin; Blumberg, Mark; Caruso, Mark; Cheok, Michael; Coe, Doug; Coyne, Kevin; Dorn, Jaclyn; Dozier, Jerry; Drozd, Andrzej; Dube, Donald; Elkins, Scott; Esmaili, Hossein; Fuller, Edward; Gavrilas, Mirela; Ghosh, Tina; Gilmer, James; Harrison, Donnie; Hart, Michelle; Hasselberg, Rick; Helton, Donald; Howe, Andrew; Hudson, Nathanael; Kauffman, John; Kelly, Joseph; Koshy, Thomas; Krepel, Scott; Lane, John; Lee, Richard; Lee, Samson; Lien, Peter; Malliakos, Asimios; Marshall, Shawn; Mitman, Jeffrey; Mrowca, Lynn; Notafrancesco, Allen; Phan, Hanh; Rini, Brett; Rodriguez, Veronica; Rubin, MichaelB; Rubin, Stuart; Salay, Michael; Schaperow, Jason; Skarda, Raymond; Staudenmeier, Joseph; Thomas, Eric; Thurston, Carl; Tinkler, Charles; Velazquez-Lozada, Alexander; Wong, See-Meng; Yarsky, Peter; Zoulis, Antonios
Subject: We are still needing some Accident Analysts later this week...especially days..please sign up for consecutive days if possible.

Thank you very much for supporting the severe accident (SA) position in the operations support center. I am now trying to complete the watch bill for the severe accident position from April 17th to May 15th. Please note that the reactor safety team has been decreased to only the accident analyst and the BWR analyst. Therefore, you need to have served previously and be very comfortable working independently in the operations center.

Due to this new manning, I have been asked to fill the positions with analysts serving at least 4-5 consecutive shifts.

I have placed an excel spreadsheet at S:\HOCSAWatchbillvolunteers to provide you with the progress so far at filling the time slots. If you are available and would like to serve during this time period please place your name in the empty time slots of the accident analyst column corresponding to the shift that you would like to serve (Please fill in all of the colored spots in the consecutive sequence). **Please do not erase any ones name (first come-first served) unless you have permission from them.** Please close the Excel file when you are complete so that others may have access to the file. If you cannot serve on consecutive shifts...please let me know if you can be a substitute for a shorter duration.

Please make sure that your volunteering is during a time frame approved by your supervisor.

Again thank you very much for serving!

Jerry Dozier
Sr. Risk and Reliability Analyst
Division of Risk Assessment
Room 010D10 MS 010C15
(301) 415-3925
Jerry.Dozier@nrc.gov

44/510

Coe, Doug

From: Correia, Richard
Sent: Tuesday, April 19, 2011 6:41 AM
To: Beasley, Benjamin; Coe, Doug
Subject: RE: Useful presentation from <http://allthingsnuclear.org> of April 14, and a SUGGESTION for improving our BWRs

Thanks Ben. An interesting idea. Why not an independent steam driven electric generator?

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Beasley, Benjamin
Sent: Monday, April 18, 2011 5:07 PM
To: Correia, Richard; Coe, Doug
Subject: FW: Useful presentation from <http://allthingsnuclear.org> of April 14, and a SUGGESTION for improving our BWRs

Rich and Doug,

John Kauffman and I discussed this idea today. We will have a proposed response for your comment tomorrow or Wednesday.

Ben

From: Sheron, Brian
Sent: Monday, April 18, 2011 11:20 AM
To: Beasley, Benjamin
Cc: Correia, Richard; Coe, Doug
Subject: FW: Useful presentation from <http://allthingsnuclear.org> of April 14, and a SUGGESTION for improving our BWRs

See below. Would this likely pass a cost-benefit backfit test?

From: Richard L Garwin [<mailto:rlg2@us.ibm.com>]
Sent: Sunday, April 17, 2011 4:25 PM
To: Larzelere, Alex
Cc: Caponiti, Alice; Busby, Jeremy T; DL-NITsolutions; Schneider, Steve
Subject: Useful presentation from <http://allthingsnuclear.org> of April 14, and a SUGGESTION for improving our BWRs

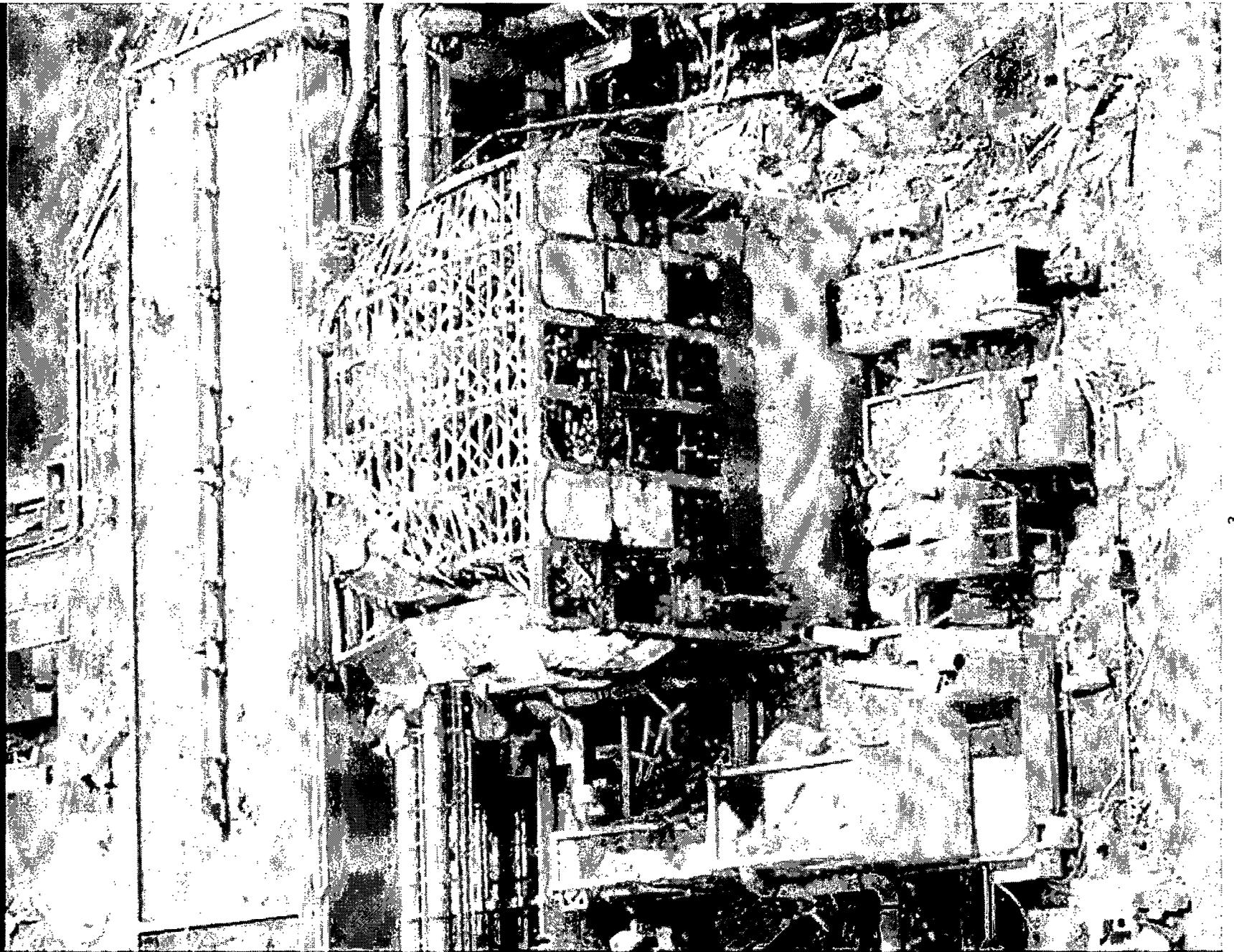
Dear Colleagues,

<http://allthingsnuclear.org> of April 14 has a very useful presentation of the Fukushima Dai-ichi problem.

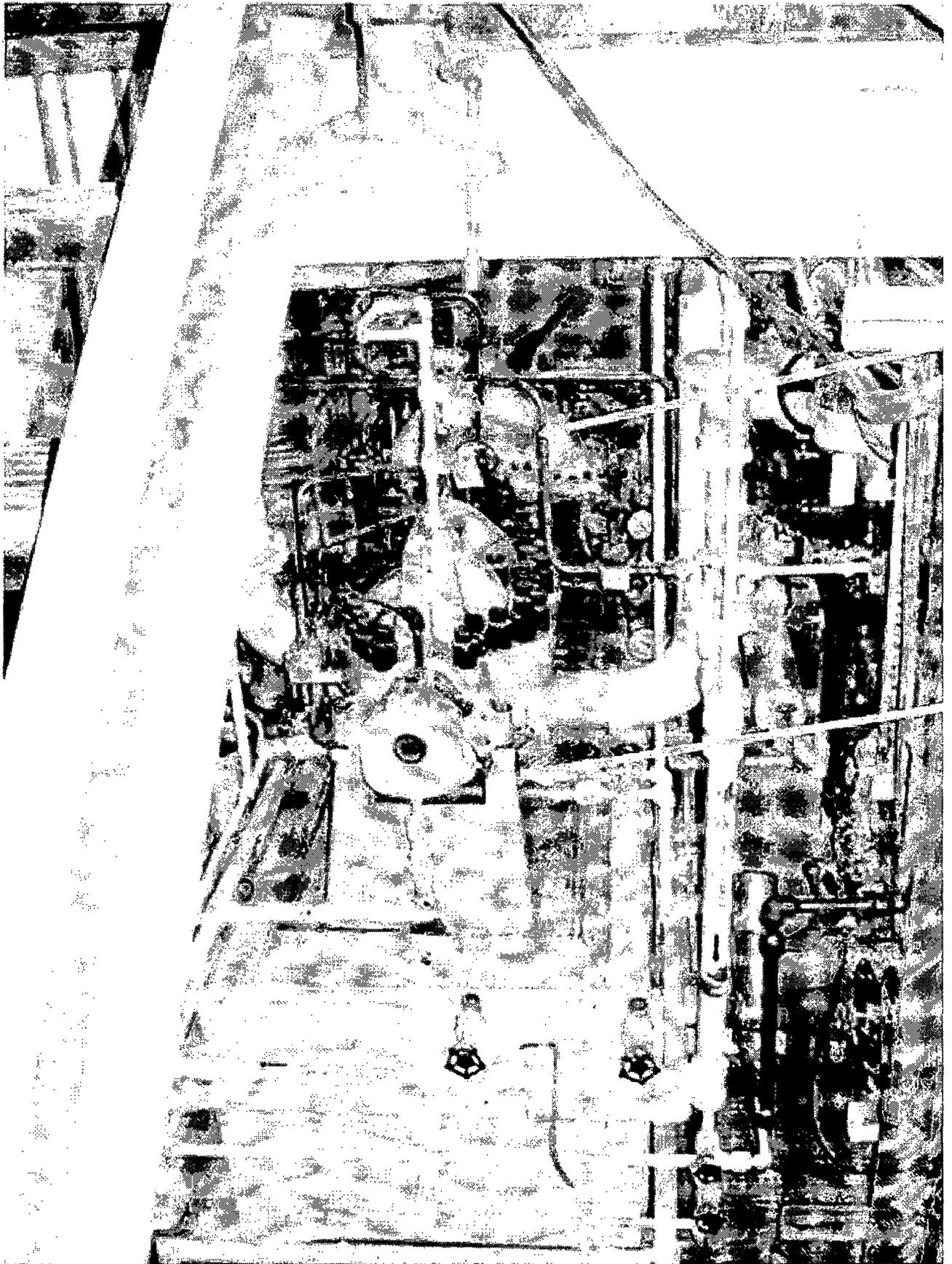
I attach the first slide and also a detail of the steam-driven "isolation turbine and pump," and provide also

YX/511

a SUGGESTION by Bill Press.



Reactor Core Isolation Co



Bill Press (William H. Press, University of Texas at Austin, and LANL) asks why the RCIC turbine/pump does not have a "magneto" on the shaft, like that on a piston-driven aircraft engine, so that whenever the pump is running there is electrical power generated for the RCIC valves and other emergency loads. This might well be used to charge the batteries, too, and operate the control room indicators and lights.

This seems to me an eminently practical suggestion, which I am passing on for communication to NE and NRC.

Dick Garwin

Coe, Doug

From: Dozier, Jerry
Sent: Tuesday, April 19, 2011 2:56 PM
To: Aissa, Mourad; Algama, Don; Alter, Peter; Armstrong, Kenneth; Bajorek, Stephen; Beasley, Benjamin; Blumberg, Mark; Caruso, Mark; Cheok, Michael; Coe, Doug; Coyne, Kevin; Dorn, Jaclyn; Dozier, Jerry; Drozd, Andrzej; Dube, Donald; Elkins, Scott; Esmaili, Hossein; Fuller, Edward; Gavrilas, Mirela; Ghosh, Tina; Gilmer, James; Harrison, Donnie; Hart, Michelle; Hasselberg, Rick; Helton, Donald; Howe, Andrew; Hudson, Nathanael; Kauffman, John; Kelly, Joseph; Koshy, Thomas; Krepel, Scott; Lane, John; Lee, Richard; Lee, Samson; Lien, Peter; Malliakos, Asimios; Marshall, Shawn; Mitman, Jeffrey; Mrowca, Lynn; Notafrancesco, Allen; Phan, Hanh; Rini, Brett; Rodriguez, Veronica; Rubin, MichaelB; Rubin, Stuart; Salay, Michael; Schaperow, Jason; Skarda, Raymond; Staudenmeier, Joseph; Thomas, Eric; Thurston, Carl; Tinkler, Charles; Velazquez-Lozada, Alexander; Wong, See-Meng; Yarsky, Peter; Zoulis, Antonios
Subject: Urgent: We are still needing Accident Analysts for day shift starting tomorrow....If you can fill in one of these days it is greatly appreciated.
Importance: High

Thank you very much for supporting the severe accident (SA) position in the operations support center. I am now trying to complete the watch bill for the severe accident position from April 17th to May 15th. Please note that the reactor safety team has been decreased to only the accident analyst and the BWR analyst. Therefore, you need to have served previously and be very comfortable working independently in the operations center.

Due to this new manning, I have been asked to fill the positions with analysts serving at least consecutive shifts.

I have placed an excel spreadsheet at S:\HOCSAWatchbillvolunteers to provide you with the progress so far at filling the time slots. If you are available and would like to serve during this time period please place your name in the empty time slots of the accident analyst column corresponding to the shift that you would like to serve (Please fill in all of the colored spots in the consecutive sequence). Please do not erase any ones name (first come-first served) unless you have permission from them. Please close the Excel file when you are complete so that others may have access to the file. If you cannot serve on consecutive shifts...please let me know if you can be a substitute for a shorter duration.

Please make sure that your volunteering is during a time frame approved by your supervisor.

Again thank you very much for serving!

Jerry Dozier
Sr. Risk and Reliability Analyst
Division of Risk Assessment
Room 010D10 MS 010C15
(301) 415-3925
Jerry.Dozier@nrc.gov

44/5/12

Ibarra, Jose

From: Rivera-Lugo, Richard
Sent: Tuesday, April 19, 2011 1:57 PM
To: RES_DE
Cc: Parks, Jazel; Dempsey, Heather
Subject: ACTION: New Expedited FOIA Request from Kyodo News (Due April 20th)
Attachments: Quick Reference - FOIA Exemptions.pdf; Kyodo News FOIA Request.pdf
Importance: High

---- REMINDER ----

DE Staff – Don't forget to provide your records for the Kyodo News FOIA.
The due date is Wednesday, April 20th @ 3:00 pm
See the original e-mail below for more details

DE Staff,

All RES divisions have been task with a new expedited FOIA Request from Kyodo News.

Please provide **ALL** documentation (This includes all "e-mails, faxes, written correspondences, meeting minutes, memos, studies, analyses") pertaining to the Japanese events **during the period of March 11th through April 11th, 2011.**

Instructions for the Kyodo FOIA request:

1. If you already submitted your records for the Associated Press (AP) and Greenpeace FOIA requests, you **DO NOT need to re-submit the records for the dates that were covered by those previous requests.**
 - AP FOIA: March 11 - 16, 2011
 - Greenpeace FOIA: March 11 - 24, 2011
2. For e-mail records, **provide only the communications that you have sent addressing the Japanese events (Sent folder).** You only have to provide items from your inbox (received e-mails) if they were sent by any person, organization or agency outside of NRC.
3. The FOIA Office has requested the staff to submit all records in **hard copies, printed single-sided.**
4. **Make sure to mark in your records any exemptions that might apply to information that, in your opinion, should not be released to the public** (e.g. pre-decisional information, personal identifiable information, proprietary information, etc). Please follow the guidance on the "*How to Respond to a FOIA Request*" document. A "Quick Reference to FOIA Exemptions" is attached for your convenience.
5. Along with your records package, **include a sheet with your name, time spent responding to this FOIA request, and a note indicating if your submission of records is partial or final.** Packages should be dropped off at the "DE's FOIA Corner" located in front of Mike Case's office (CSB-5 A05).

More information on the active FOIA requests for RES can be found accessing the link below.
<http://www.internal.nrc.gov/RES/FOIA/index.htm>

44/513

Please use TAC# ZF0001 to record your time in HRMS related to activities in response to a FOIA request.

**Provide hard copies only of any records that meet the above criteria by 3:00 PM
on Wednesday, April 20th.**

If you have any questions please contact me or Jazel Parks, and we will do our best to address your concerns.

Thanks,
Richie

Richard Rivera-Lugo, EIT, MEM
Technical Assistant (Acting)
U.S. Nuclear Regulatory Commission – HQ
RES/DE
Ph. 301-251-7652
Fax 301-251-7420
Mail M.S. C5C07M
E-mail Richard.Rivera-Lugo@nrc.gov

 Please consider the Environment before printing this e-mail.

Ibarra, Jose

From: Dempsey, Heather
Sent: Tuesday, April 19, 2011 5:24 PM
To: Correia, Richard
Cc: Ibarra, Jose
Subject: RE: FOIA support

Hi Rich,

Since they cannot filter your mailbox for just Japan related material for this request, would you like for me to request that your emails be printed and provided to you to sort through? The other option would be you manually searching and printing Japan related items from your email.

Please advise.

Thanks!

From: Correia, Richard
Sent: Tuesday, April 19, 2011 11:25 AM
To: Dempsey, Heather
Subject: FW: FOIA support

Heather,

I (unsuccessfully) asked OIS for assistance with a FOIA request (see below). I understand that PMDA (you) can help me. What do you need from me at this point?

Many thanks in advance!

Rich

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Correia, Richard
Sent: Tuesday, April 19, 2011 11:19 AM
To: ICOD Support (FOIA); ICsupport Resource; Craver, Patti; Williams, Michael
Subject: RE: FOIA support

Thank you Bob. I work in RES so I'll contact our Office POC for this effort.

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

YY/514

From: ICOD Support (FOIA)
Sent: Tuesday, April 19, 2011 10:04 AM
To: Correia, Richard; ICSupport Resource; Craver, Patti; Williams, Michael
Subject: RE: FOIA support

Richard –

We are requesting that all requests for FOIA email support be coordinated through your Program Office FOIA Coordinator to make it easier for everyone to keep track of all of the activities. I have been working with Patti Craver in NRR on many other requests and it would be much easier for everyone to have all of the requests come through her.

Also we currently cannot filter the email based on specific material in the messages or attachments. We can only pull the whole mailbox between specific dates and either provide someone a copy of it that they can work with or just try and PDF the whole mailbox and print everything out. I would suggest coordinating with Patti to determine exactly what you need and see if we can help you in any way.

Thanks!

Bob

From: Correia, Richard
Sent: Monday, April 18, 2011 7:13 AM
To: ICOD Support (FOIA); ICSupport Resource
Cc: Randall, Bob
Subject: FOIA support

ICOD, Bob,

I request your assistance with a FOIA that asks for “all documentation pertaining to the Japanese event during the period of March 11, 2011 through April 11, 2011”. Specifically, I request your assistance with identifying and printing any email and their attachments under my account, Richard.Correia@NRC.GOV.

Please contact me should there be any questions.

Regards,

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

Wittick, Brian

From: Wittick, Brian
Sent: Wednesday, April 20, 2011 7:29 PM
To: Casto, Chuck
Cc: Reynolds, Steven
Subject: FW: NISA Request
Attachments: 50-54(x)&(y)48FR13966.pdf

FYI – HQ has provided NISA answers to part of their questions (the legal piece) regarding TMI, and remains in active dialogue through the normal IP cooperation channels.

VR
Brian

From: Bloom, Steven
Sent: Wednesday, April 20, 2011 8:04 AM
To: bannai-toshihiro@meti.go.jp
Cc: Foggie, Kirk; Emche, Danielle
Subject: NISA Request

Dear Bannai-san,

Below is the response I have gotten from our legal staff regarding your request on legal issues related to TMI:

Strictly speaking, as far as we know, the NRC did not take any action by rule which would deem legal and justified any responsive action taken by the TMI licensee at the time of and immediately following the 1979 accident.

However, the NRC did adopt new regulations in 10 CFR 50.54(x) and (y) to ensure that licensees would be able to take timely and necessary action even though such action would be in violation of the plant's technical specifications, license conditions or other regulatory requirements. The final rule for these provisions is 48 FR 13966 (April 1, 1983). A copy of the SOC for the final rule is attached. Our legal view is that this regulation may be applied only when the licensee action is needed to avoid imminent radiological harm the general public, i.e., in quickly emerging situations where fast action is needed to avoid radiological harm to the general public. The staff's practice has been more lenient, however, despite OGC's interpretation.

If you have any questions, please let me know.

Thank you,

Steve

Steven Bloom, International Relations Specialist
International Cooperation and Assistance Branch (ICA)
301-415-2431
O-4F4
M/S O-4E21

YX/515

HEINONLINE

Citation: 48 Fed. Reg. 13966 1983

Content downloaded/printed from
HeinOnline (<http://heinonline.org>)
Tue Apr 19 16:08:00 2011

- Your use of this HeinOnline PDF indicates your acceptance of HeinOnline's Terms and Conditions of the license agreement available at <http://heinonline.org/HOL/License>
- The search text of this PDF is generated from uncorrected OCR text.

million or more; will not cause a major increase in costs or prices for consumers, individual industries, Federal, State or local government agencies, or geographic regions; and will not have a significant adverse effect on competition, employment or investment, productivity, innovation, or ability of United States-based enterprises to compete with foreign-based enterprises in domestic or export markets.

Dr. S. T. Wilson, Jr., Director, National Program Planning Staffs, VS, APHIS, USDA, has determined that an emergency situation exists which warrants publication without prior opportunity for a public comment period on this interim action. This amendment relieves restrictions presently imposed on mares over 731 days of age being imported into the United States, and should be made effective immediately in order to permit affected persons to move these mares into the United States without unnecessary restrictions.

Therefore, pursuant to the administrative procedure provisions in 5 U.S.C. 553, it is found upon good cause that notice and other public procedure with respect to this emergency interim action is impracticable, unnecessary and contrary to the public interest, and good cause is found for making this emergency interim action effective less than 30 days after publication of this document in the Federal Register.

Comments have been solicited for 60 days after publication of this document, and this emergency interim action will be scheduled for review so that a final document discussing comments received and any amendments required can be published in the Federal Register as soon as possible.

Certification Under the Regulatory Flexibility Act

Mr. James O. Lee, Jr., Acting Administrator of the Animal and Plant Health Inspection Service, has determined that this action will not have a significant economic impact on a substantial number of small entities because it is anticipated that it will affect only a portion of the approximately 20 mares out of 6,000 horses imported into the United States each year which come from countries where CEM is known to exist and which arrive in the United States without the required surgical treatment.

Alternatives Considered

The alternatives considered in making this decision were: (1) To allow the required surgical treatment of such horses to be performed at the College of Veterinary Medicine, University of California, Davis, California; and (2) Not

to allow the required surgical treatment to be performed at that facility.

Alternative 2 was rejected as this would leave importers with no option but to use the Cornell University facilities in Ithaca, New York. Alternative 1 was adopted because this would provide importers with a choice of facilities, and would eliminate costly transportation of animals across the country for treatment.

List of Subjects in 9 CFR Part 92

Animal diseases, Imports, Livestock and livestock products, Quarantine, Transportation, Contagious equine metritis (CEM).

PART 92—IMPORTATION OF CERTAIN ANIMALS AND POULTRY AND CERTAIN ANIMALS AND POULTRY PRODUCTS; INSPECTION AND OTHER REQUIREMENTS FOR CERTAIN MEANS OF CONVEYANCE AND SHIPPING CONTAINERS THEREON

Accordingly, Part 92, Title 9, Code of Federal Regulations is amended in the following respects:

1. In § 92.2(i)(2)(v), the first sentence of paragraph (H) is amended to read:

§ 92.2 General prohibitions; exceptions.

- * * *
- (1) * * *
- (2) * * *
- (v) * * *
- * * *

(H) Any mare subject to the provisions of § 92.2(i)(2)(v) which is found upon examination during preentry quarantine to have had an incomplete clitoral sinusectomy, but which is otherwise eligible for entry, may, at the option and expense of the importer, be moved to the School of Veterinary Medicine, Cornell University, Ithaca, New York, or to the College of Veterinary Medicine, University of California, Davis, California, where the surgery required to qualify such mare for importation may be performed by a licensed veterinarian mutually acceptable to the importer, the University, and the Department. * * * (Sec. 2, 32 Stat. 792, as amended; secs. 2, 11, 76 Stat. 129, 130, 132; sec. 1, 84 Stat. 202, (21 U.S.C. 111, 134a, 134c, and 134f); 37 FR 28464, 28477; 38 FR 19141)

Done at Washington, D.C., this 30th day of March 1983.

J. K. Atwell,
Deputy Administrator, Veterinary Services.
[FR Doc. 83-8573 Filed 3-30-83; 11:58 am]
BILLING CODE 3410-34-M

NUCLEAR REGULATORY COMMISSION

10 CFR Part 50

Applicability of License; Conditions and Technical Specifications in an Emergency

AGENCY: Nuclear Regulatory Commission.

ACTION: Final rule.

SUMMARY: The Nuclear Regulatory Commission is amending its regulations to clarify that all Part 50 licensees may take reasonable action that departs from a license condition or technical specification in an emergency when this action is immediately needed to protect the public health and safety. The rule is being issued because NRC regulations currently do not permit deviations from license conditions or technical specifications under any conditions. Emergency situations can arise, though, during which a license condition or a technical specification could prevent necessary protective action by the licensee. The rule allows this action to be taken in emergency circumstances.

EFFECTIVE DATE: June 1, 1983.

FOR FURTHER INFORMATION CONTACT: Charles M. Trammell III, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555 (Telephone: 301-492-7389).

SUPPLEMENTARY INFORMATION: The rule clarifies the regulations in 10 CFR Part 50 by providing that a licensee may take reasonable action that departs from a license condition or a technical specification in an emergency when such action is immediately needed to protect the public health and safety.

At present, NRC regulations do not permit deviations from license conditions or technical specifications under any circumstances. Emergencies can arise, though, during which compliance with a license condition or a technical specification could prevent necessary action by a licensee to protect the public health and safety. Licensees are understandably reluctant to take actions contrary to their licenses. Absolute compliance with the license in emergencies can be a barrier to effective protective action by a licensee.

Technical specifications contain a wide range of operating limitations and requirements concerning actions to be taken if certain systems fail and if certain parameters are exceeded. The bulk of technical specifications are devoted to keeping the plant parameters within safe bounds and keeping safety

equipment operable during normal operation. However, technical specifications also require the implementation of a wide range of operating procedures which go into great detail as to actions to be taken in the course of operation to maintain facility safety. These procedures are based on the various conditions—normal, transient and accident conditions—analyzed as part of the licensing process. Nevertheless, unanticipated circumstances can occur during the course of emergencies. These circumstances may call for responses different from any considered during the course of licensing—e.g., the need to isolate the accumulators to prevent nitrogen injection to the core while there was still substantial pressure in the primary system was unforeseen in the licensing process before TMI-2; thus, the technical specifications prohibited this action. Special circumstances requiring a deviation from license requirements are not necessarily limited to transients or accidents not analyzed in the licensing process. Special circumstances can arise during emergencies involving multiple equipment failure or coincident accidents where plant emergency procedures could be in conflict, or not applicable to the circumstances. In addition, an accident can take a course different from that visualized when the emergency procedure was written, thus requiring a protective response at variance with a procedure required to be followed by the licensee. Also, performance of routine surveillance testing, which might fall due during an emergency, could either divert the attention of the operating crew from the emergency or cause the loss of equipment needed for proper protective action.

Technical specifications or license conditions can be amended by NRC, and the rule is not intended to apply in circumstances where time allows this process to be followed. The rule would apply only to those emergency situations where action by the licensee is required immediately to protect the public health and safety—action which may be contrary to a technical specification or a license condition.

It is the intent of the rule to allow deviations from license requirements only in the special circumstances described. It is not intended that licensees be allowed to deviate from procedures and other license requirements where these are applicable.

For these reasons, the Commission believes that there should be a specific provision in the Commission's rules

clearly indicating that a licensee may take reasonable action that departs from a license condition or technical specification in an emergency when such action is immediately needed to protect the public health and safety.

The rule also requires a licensee, under § 50.72, to notify the NRC Operations Center by telephone of emergency circumstances requiring it to take any action that departs from a license condition or a technical specification. When time permits, the notification is made before the protective action is taken; otherwise, it is made as soon as possible thereafter. The impact of this reporting requirement on licensees is expected to be negligible.

The rule follows the recommendation in NUREG-0616, "Report of Special Review Group, Office of Inspection and Enforcement on Lesson Learned from Three Mile Island"¹ the NRC establish and announce a firm policy regarding the applicability of the license under emergency circumstances, with certain exceptions discussed below.

(a) The rule does not require that departure from a license condition or technical specification have the concurrence of the most senior licensee and NRC personnel available at the time before the departure.

While the Commission certainly does not disagree with the general concept that the most senior licensee personnel available at the time should be involved, the rule specifies that such action shall be approved by a licensed senior operator as a minimum and does not go into further detail as to which additional persons should be involved if time permits or which persons should be involved under other circumstances. The persons responsible for safe operation of the facility are already identified in the facility license and implementing procedures.

(b) The rule does not require the concurrence of NRC personnel. Receiving the "concurrence" or "approval" of NRC personnel would amount to a license amendment using procedures contrary to those existing for amendments. The rule specifically applies to emergency situations where immediate action is needed and time is not available for a license amendment. Requiring the concurrence of NRC personnel available at the time tends to shift the burden of safety from the licensee to NRC—contrary to the rule's intent. It could also shift the burden to NRC personnel on site who may be unqualified to concur in a proposed licensee action.

¹ NUREG-0616 is available for inspection and copying for a fee at NRC Public Document Room, 1717 H Street, NW, Washington, D.C. Copies may be purchased through the NRC/GPO Sales Program by using a GPO Deposit Account, MasterCard or Visa by calling the NRC/GPO Sales Office on (301) 492-8530 or by sending a check or money order payable to Superintendent of Documents to: Sales Manager 058, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555. Purchase orders are acceptable from Federal, state, and local government offices only.

The rule was published as a proposed rule in the Federal Register on August 18, 1982 (47 FR 35996). A sixty-day comment period expired on October 18, 1982.

A total of thirty-seven responses were received, representing thirty-nine organizations or persons. Respondees included: licensees of power reactors (24), individuals (5), research reactor licensees (2), nuclear steam system suppliers (2), professional organizations (2); and one response each from: a law firm, a State, a labor union, and an architectural-engineering firm. Copies of comments received by the Commission in response to the notice of proposed rulemaking may be examined in the Commission's Public Document Room at 1717 H Street, NW., Washington, D.C. (file PR-50, 47 FR 35996).

The vast majority of the commenters (thirty-seven) were in favor of the rule. Many expressed enthusiastic support. Only two commenters believed that the rule should not be adopted. Eight commenters believed the rule should be issued as proposed. However, as a result of comments received by others, some changes have been made, as discussed below.

One commenter pointed out the similarity between the proposed rule and the so-called "General Prudential Rule" contained in both the International Regulations for Preventing Collisions at Sea, 1972, and the Inland Navigational Rules Act of 1980. The rule is identical in each and states:

In construing and complying with these Rules due regard shall be had to all dangers of navigation and collision and to any special circumstances, including the limitations of the vessels involved, which may make a departure from those rules necessary to avoid immediate danger. (Rule 2(b)).

The commenter added that a Commanding Officer (of a naval ship) is permitted to deviate from written rules to the extent necessary to save his ship, and that there is ample precedent for the proposed NRC rule.

It is also very similar to a rule of the Federal Aviation Administration (FAA) governing the operation of aircraft, 14 CFR 91.3, which states that "[i]n an emergency requiring immediate action, the pilot in command may deviate from any rule * * * to the extent necessary to meet that emergency. Each pilot in command who deviates from a rule * * * shall, upon the request of the Administrator, send a written report of that deviation to the Administrator."

The Commission had both the General Prudential Rule and the FAA rule in mind when it framed the proposed NRC rule. Further, it is clear that Congress

believes that licensees have authority to take whatever action is necessary to respond to emergencies involving an imminent threat to public health and safety. H.R. Rep. No. 97-884, 97th Cong., 2d Sess. 38 (1982). The rule codifies and clarifies this authority.

In addition to seeking the usual public comment as to any aspects of the proposed rule, the Federal Register Notice of the proposed rule stated:

The proposed rule does not provide significant guidance to Part 50 licensees for identifying those situations in which deviations from license conditions or technical specifications are allowable. In addition, the proposed rule and the supplementary information does not contain standards to be used by the NRC staff in determining whether to take enforcement action against Part 50 licensees who deviate from license conditions or technical specifications in these types of situations. The Commission particularly solicits comments on these two areas.

Thirty-four comments were received in response to this request, and most were strongly opposed to the Commission providing additional deviation guidance or enforcement standards.

As for deviation guidance, one comment, which was opposed to such, was typical: "[w]e do not believe that it is feasible to provide detailed guidance as to when deviations are permissible. The whole purpose of the proposed amendments is to provide flexibility in situations that cannot be anticipated. Any effort to provide more detailed standards is likely to defeat that purpose by unintentionally excluding a situation in which a deviation is necessary or appropriate."

The Commission agrees with this comment, and feels that any attempt to define in more detail the precise circumstances under which a deviation is permissible is bound to exclude a circumstance where deviation might be entirely appropriate. Whereas the conditions under which a deviation is allowed are not described at length, nevertheless, the deviation criteria are quite specific: the licensee must be faced with an emergency situation in which compliance with the license is posing a barrier to effective protective action and rapid protective action is needed.

Based on the foregoing and public comments received, no changes have been made to the rule with respect to the conditions under which the rule may be invoked.

In response to the Commission's request for comments on the need for enforcement standards, most commenters stated that the matter of enforcement should be based on the

specific circumstances surrounding the event, and that enforcement standards would be difficult to frame for the unusual circumstances under which the rule might be used. One commenter pointed out that enforcement standards would tend to limit actions that could or could not be taken, and thereby serve to provide deviation guidance which most felt was inappropriate (discussed above).

The Commission has concluded that enforcement standards, as such, are not needed. The Commission agrees that providing such standards would tend to define the circumstances under which the rule could be used (deviation guidance). As discussed above, this has been judged to be undesirable.

The rule does, however, contain implicit enforcement guidance. The NRC would review a licensee's use of the rule to determine answers to the following types of questions.

a. Did the licensee have to act immediately to avert possible adverse consequences to the public health and safety?

b. Was adequate or equivalent protective action that is consistent with the license immediately apparent?

c. Was the action reasonable? Based on information available at the time did it serve to protect the public health and safety? Did the licensee deviate from its license only to the extent necessary to meet the emergency?

d. Was there time for an amendment of the license to be approved by NRC?

Answers to these questions should be adequate to determine if the rule had been violated. Specific enforcement action would have to depend on the specific circumstances.

Ten persons made comments to the effect that overly critical reviews or overzealous enforcement action following the use of the rule would cause licensees to hesitate to use the rule. The Commission agrees with these comments. The Commission recognizes that a licensee will need to exercise judgment in applying the rule, and in its after-the-fact review, it may not agree in every instance with the licensee's actions. However, enforcement action for a violation of the rule will not be taken unless a licensee's action was unreasonable considering all the relevant circumstances having to do with the emergency.

The Federal Register Notice for the proposed rule contained additional comments of Commissioner Gilinsky, in which he stated:

I believe the decision to operate outside the Technical Specifications should be made by a senior reactor operator since I understand that reactor operators are not trained or

tested on both the basis and importance of the Technical Specifications. I would be interested in receiving comments on this issue.

Nineteen comments were received in response to this request and most all agreed that such a decision should be made, as a minimum, by a licensed senior operator. Those opposed expressed the opinion that such concurrence should not be mandatory or that higher concurrences should be obtained if possible.

A minor clarifying change to the rule has been made in response to these comments and another which stated that the rule was confusing because the first paragraph of the proposed rule discussed *licensees* and the second discussed *operators*. The second paragraph now reads: "Licensee action permitted by paragraph (x) of this section shall be approved, as a minimum, by a licensed senior operator." This change makes it clear that if a licensee takes emergency action allowed by paragraph (x), such action must be approved by, at least, a licensed senior operator acting for the licensee. Under the provision, any licensed senior operator (licensed for the unit involved) would be sufficient. However, as one commenter pointed out, more senior licensee personnel would probably be available. If so, the decision to depart from the license in an emergency would pass to them (as higher authorities in the chain of command). If, however, an emergency requiring prompt action should occur on a back shift, no licensee representative higher in the chain of command is likely to be available. To require other approvals could serve to defeat the purpose of the rule.

One commenter stated that the rule should provide for deviations from the NRC regulations as well as license conditions and technical specifications. This was intended, and the language of numerous comments indicated that this was understood. Each license issued is subject to all applicable rules, regulations and orders of the Commission. This is stated in the license itself and also in 10 CFR 50.54(h) as a condition of the license. Therefore, the rule does apply to NRC rules, regulations and orders as well.

Three comments were received regarding the applicability of the rule in situations where damage to the facility or injury to personnel might be involved. For the reasons discussed above, the rule does not contain explicit deviation guidance or examples. Nevertheless, the threat of injury to personnel would be an appropriate example. As for invoking the rule to prevent damage to the facility,

or machinery, it would depend on the specific circumstances of the emergency. The rule does not apply to machinery or the facility, *per se*, but would apply if such damage is tied to a possible adverse effect on public health and safety.

One commenter suggested that the Commission emphasize the permissive nature of the rule by explaining that its use is totally discretionary, that licensees need not invoke it even in an emergency, and that failure to invoke the rule would not constitute a violation of NRC requirements for which an enforcement action may be brought. This comment was not accepted. Whereas the language of the rule is permissive in nature, licensees are responsible for operating their facilities in such a manner as to protect the public health and safety. If, in an emergency, protective action is needed (and no action consistent with the license that can provide adequate or equivalent protection is immediately apparent) the licensee would be obliged to take the protective action that deviates from the license. Viewed in this sense, use of the rule is not optional.

One commenter suggested that the provisions of the rule be placed in the facility operating license indicating that Technical Specifications are not intended to prevent a licensee from undertaking, during the course of emergency conditions, any action necessary to protect public health and safety. No changes to the rule have been made in response to this comment. First, as stated above, the rule applies not only to technical specifications, but any NRC requirement, e.g., regulations, rules, license conditions, or technical specifications. Second, it is not necessary to place the statement into the operating license itself, since it is being published as a rule in § 50.54, "Conditions of licenses." By so doing, the rule applies to all operating licenses.

A commenter suggested that a policy statement to the same safe effect would be better than a rule. This was not accepted, since the Commission believes that it would be inappropriate to issue a policy statement in conflict with a rule.

Only two commenters were not in favor of the rule. One comment stated that the rule would be abused. The Commission disagrees with this comment, noting that several safeguards have been built into the rule to prevent this. First, licensees must notify the NRC by telephone when the rule is used. Second, the NRC may require written statements from a licensee concerning its actions after use of the rule. One commenter agreed that these provisions

provided adequate safeguards against abuse.

Two commenters suggested that written notice to the Commission of use of the rule should be mandatory. It is highly likely that a written report would be required since most violations of the license or technical specifications do require a written report. To the extent that the Commission's information needs related to the event are not met, the Commission would require additional information, as provided for in the rule. A mandatory written report is therefore not deemed essential.

One commenter stated that the reporting requirement "When time permits, the notification (of the use of the rule) shall be made before the protective action is taken * * *" was inconsistent with the use of the term "immediately needed" language of the rule, and implied that a prior report should not be required at all. In response, the Commission notes that all power reactors have dedicated telephones connected directly to the NRC Operations Center at all times, and, under most circumstances under which the rule might need to be used, the licensee would be in contact with the NRC Operations Center anyway. Therefore, most emergency situations would allow time to make a prior notification to the NRC, considering the ease and speed that it could be done. Second, while the term "immediately" as used in the rule is not defined, it could involve a period of hours as the emergency develops, and certainly a period of time that is too short to permit NRC approval of a change to the license before the action must be taken (as stated earlier). Therefore, there is not necessarily an inconsistency between the prior report and the timing of the need for action. If, however, there is no time for a prior report, it is not required.

One commenter stated that the rule constituted an admission that NRC rules and licenses are not adequate; another stated that the rule shows that NRC rules have become unwieldy. The Commission does not agree with these comments, and believes the issuance of the rule will result in increased protection to the public health and safety. Any attempt to define NRC requirements to cover all conceivable circumstances, as discussed earlier, is bound to fail, and would result in unwieldy regulations.

One comment noted an apparent inconsistency between the rule (which admits that unanticipated circumstances can occur during the course of emergencies that may call for responses different from any considered during the

course of licensing) and the admissibility of intervenor contentions that are denied litigation at a hearing on the basis that such scenarios are incredible or so unlikely as to be barred from litigation.

The Commission, in issuing this rule, takes no position whatever as to the merit of any contention involving emergency circumstances that could be postulated at a nuclear facility. Rather, the rule assumes that special circumstances have occurred which makes use of the rule necessary to protect the public health and safety.

A commenter suggested that use of the rule be tied to the "general emergency" emergency classification, i.e., that the rule should apply only when a general emergency has been declared by the licensee. This comment was not accepted. Emergencies can develop rapidly. Use of the rule should not be encumbered by administrative prerequisites.

A commenter proposed that a large fee—up to one million dollars—be charged for use of the rule. The thrust of the comment was to ensure that violation of NRC requirements be carefully considered. Another suggested holding hearings after the emergency to determine justifications for use of the rule and to see if other actions could have been taken. As stated earlier, the Commission believes that the rule contains adequate safeguards. Therefore these comments were not adopted.

Finally, a commenter suggested that an evaluation be made of each instance in which a deviation was made to prevent possible future need for similar deviations. The Commission will review each use of the rule both to confirm that the intent of the rule was satisfied and also to analyze the circumstances leading to the emergency to see what permanent corrective action may be appropriate.

Regulatory Analysis

The Commission has prepared a regulatory analysis for this regulation. The analysis examines the costs and benefits of the rule as considered by the Commission. A copy of the regulatory analysis is available for inspection and copying for a fee at the NRC Public Document Room, 1717 H Street, NW., Washington, D.C. Single copies of the analysis may be obtained from Charles M. Trammell III, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C., 20555, Telephone (301) 492-7389.

Paperwork Reduction Act Statement

The information collection requirements contained in this regulation have been approved by the Office of Management and Budget; OMB approval No. 3150-0011.

Regulatory Flexibility Certification

In accordance with the Regulatory Flexibility Act of 1980, 5 U.S.C. 605(b), the Commission hereby certifies that these regulations will not, if promulgated, have a significant economic impact on a substantial number of small entities. These regulations affect licensees that own and operate nuclear utilization facilities licensed under sections 103 and 104 of the Atomic Energy Act of 1954, as amended. The amendment serves to clarify the applicability of license conditions and technical specifications in an emergency. The clarification would be incorporated as a condition of the respective operating licenses, and would require no action on the part of licensees. Accordingly, there is no new, significant economic impact on these licensees; nor do these licensees fall within the definition of small businesses set forth in section 3 of the Small Business Act, 15 U.S.C. 632, or within the Small Business Size Standards set forth in 13 CFR Part 121.

List of Subjects in 10 CFR Part 50

Antitrust, Classified information, Fire prevention, Intergovernmental relations, Nuclear power plants and reactors, Penalty, Radiation protection, Reactor siting criteria, and Reporting and recordkeeping requirements.

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, as amended, and section 553 of Title 5 of the United States Code, the following amendments to Title 10, Chapter I, Code of Federal Regulations, Part 50 are published as a document subject to codification.

PART 50—DOMESTIC LICENSING OF PRODUCTION AND UTILIZATION FACILITIES

1. The authority citation for Part 50 continues to read as follows:

Authority: Secs. 103, 104, 161, 182, 183, 188, 189, 68 Stat. 938, 937, 948, 953, 954, 955, 956, as amended, sec. 234, 83 Stat. 1244, as amended (42 U.S.C. 2133, 2134, 2201, 2232, 2233, 2236, 2239, 2282); secs. 201, 202, 206, 68 Stat. 1242, 1244, 1246, as amended (42 U.S.C. 5841, 5842, 5846), unless otherwise noted.

Section 50.7 also issued under Pub. L. 95-601, sec. 10, 92 Stat. 2951 (42 U.S.C. 5851). Section 50.78 also issued under sec. 122, 68 Stat. 939 (42 U.S.C. 2152). Sections 50.80-50.81 also issued under sec. 184, 68 Stat. 954, as amended (42 U.S.C. 2234). Sections 50.100-

50.102 issued under sec. 188, 68 Stat. 955 (42 U.S.C. 2238).

For the purposes of sec. 223, 68 Stat. 958, as amended (42 U.S.C. 2273), §§ 50.10 (a), (b), and (c), 50.44, 50.46, 50.48, 50.54, and 50.80(a) are issued under sec. 161b, 68 Stat. 948, as amended (42 U.S.C. 2201(b)); §§ 50.10 (b) and (c) and 50.54 are issued under sec. 161i, 68 Stat. 949, as amended (42 U.S.C. 2201(i)); and §§ 50.55(e), 50.59(b), 50.70, 50.71, 50.72, and 50.78 are issued under sec. 161o, 68 Stat. 950, as amended (42 U.S.C. 2201(o)).

2. New paragraphs (x) and (y) are added to § 50.54 to read as follows:

§ 50.54 Conditions of licenses.

* * * * *

(x) A licensee may take reasonable action that departs from a license condition or a technical specification (contained in a license issued under this part) in an emergency when this action is immediately needed to protect the public health and safety and no action consistent with license conditions and technical specifications that can provide adequate or equivalent protection is immediately apparent.

(y) Licensee action permitted by paragraph (x) of this section shall be approved, as a minimum, by a licensed senior operator prior to taking the action.

3. A new paragraph (c) is added to § 50.72 to read as follows:

§ 50.72 Notification of significant events.

* * * * *

(c) Each licensee licensed under § 50.21 or § 50.22 shall notify the NRC Operations Center by telephone of emergency circumstances requiring it to take any protective action that departs from a license condition or a technical specification, as permitted by § 50.54(x) of this part. When time permits, the notification must be made before the protective action is taken; otherwise, the notification must be made as soon as possible thereafter. The Commission may require written statements from a licensee concerning its actions taken under the provisions of § 50.54(x) of this part.

Dated at Bethesda, Maryland this 10 day of March, 1983.

For the Nuclear Regulatory Commission,

William J. Dircks,
Executive Director for Operations.

[FR Doc. 83-8406 Filed 3-31-83; 8:45 am]

BILLING CODE 7590-01-M

FEDERAL TRADE COMMISSION**16 CFR Part 13**

[Docket C-3107]

Meredith Corp.; Prohibited Trade Practices, and Affirmative Corrective Actions

AGENCY: Federal Trade Commission.

ACTION: Consent Order.

SUMMARY: In settlement of alleged violations of federal law prohibiting unfair acts and practices and unfair methods of competition, this consent agreement requires a Des Moines, Iowa franchisor and operator of the Better Homes and Gardens Real Estate Service (Service), among other things, to cease making false or misleading representations regarding the Service, its members, or services offered. The order prohibits the dissemination of advertisements and promotional materials which represent that all Service members offer consumers "settling-in" services; participate in a home-building program; and offer "exclusive" home-protection insurance, unless the advertisement clearly discloses that not all members offer these services. The corporation is also barred from making unsubstantiated representations concerning the Service's selectivity in choosing members; training of sales associates of Service members; market size, rank and leadership in terms of sales volume of Service members; or any statement which compares Service members to other real estate franchisors as to calibre of members or membership standards. Further, the order requires the corporation to send all members of the Better Homes and Gardens Real Estate Service a letter recalling certain advertising and promotional materials, and an acknowledgment form.

DATE: Complaint and order issued March 15, 1983.¹

FOR FURTHER INFORMATION CONTACT: FTC/PA, Andrew B. Sacks, Washington, D.C. 20580. (202) 724-1490.

SUPPLEMENTARY INFORMATION: On Monday, Dec. 27, 1982, there was published in the Federal Register, 47 FR 57499, a proposed consent agreement with analysis in the Matter of Meredith Corporation, a corporation, for the purpose of soliciting public comment. Interested parties were given sixty (60) days in which to submit comments, suggestions or objections regarding the proposed form of order.

¹ Copies of the Complaint and the Decision and Order filed with the original document.

Wittick, Brian

From: Wittick, Brian
Sent: Wednesday, April 20, 2011 7:25 PM
To: Abrams, Charlotte
Subject: FW: NISA Request

Charlotte,

I recommend we have as consistent a POC for Bannai as possible. I think he is having difficulty keeping track of all the changing faces interfacing with him.

Thanks
Brian

From: Bloom, Steven
Sent: Wednesday, April 20, 2011 8:04 AM
To: bannai-toshihiro@meti.go.jp
Cc: Foggie, Kirk; Emche, Danielle
Subject: NISA Request

Dear Bannai-san,

Below is the response I have gotten from our legal staff regarding your request on legal issues related to TMI:

Strictly speaking, as far as we know, the NRC did not take any action by rule which would deem legal and justified any responsive action taken by the TMI licensee at the time of and immediately following the 1979 accident.

However, the NRC did adopt new regulations in 10 CFR 50.54(x) and (y) to ensure that licensees would be able to take timely and necessary action even though such action would be in violation of the plant's technical specifications, license conditions or other regulatory requirements. The final rule for these provisions is 48 FR 13966 (April 1, 1983). A copy of the SOC for the final rule is attached. Our legal view is that this regulation may be applied only when the licensee action is needed to avoid imminent radiological harm the general public, i.e., in quickly emerging situations where fast action is needed to avoid radiological harm to the general public. The staff's practice has been more lenient, however, despite OGC's interpretation.

If you have any questions, please let me know.

Thank you,

Steve

Steven Bloom, International Relations Specialist
International Cooperation and Assistance Branch (ICA)
301-415-2431
O-4F4
M/S O-4E21

YY/516

Ibarra, Jose

From: Dempsey, Heather
Sent: Wednesday, April 20, 2011 9:28 AM
To: Correia, Richard
Cc: Ibarra, Jose
Subject: RE: FOIA support

Hi-

They should be able to. At one point there were having problems with PDF's but I believe that has been fixed. I will send the request today for 3/11- 4/15 (These dates will cover the new FOIA we just received yesterday as well, which request Japan email till 4/15).

From: Correia, Richard
Sent: Wednesday, April 20, 2011 7:16 AM
To: Dempsey, Heather
Cc: Ibarra, Jose
Subject: RE: FOIA support

Hi Heather,

Can OIS also print any attachments to emails?

Rich

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Dempsey, Heather
Sent: Tuesday, April 19, 2011 5:24 PM
To: Correia, Richard
Cc: Ibarra, Jose
Subject: RE: FOIA support

Hi Rich,

Since they cannot filter your mailbox for just Japan related material for this request, would you like for me to request that your emails be printed and provided to you to sort through? The other option would be you manually searching and printing Japan related items from your email.

Please advise.

Thanks!

From: Correia, Richard
Sent: Tuesday, April 19, 2011 11:25 AM
To: Dempsey, Heather
Subject: FW: FOIA support

44/517

Heather,

I (unsuccessfully) asked OIS for assistance with a FOIA request (see below). I understand that PMDA (you) can help me. What do you need from me at this point?

Many thanks in advance!

Rich

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Correia, Richard
Sent: Tuesday, April 19, 2011 11:19 AM
To: ICOD Support (FOIA); ICSupport Resource; Craver, Patti; Williams, Michael
Subject: RE: FOIA support

Thank you Bob. I work in RES so I'll contact our Office POC for this effort.

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: ICOD Support (FOIA)
Sent: Tuesday, April 19, 2011 10:04 AM
To: Correia, Richard; ICSupport Resource; Craver, Patti; Williams, Michael
Subject: RE: FOIA support

Richard –

We are requesting that all requests for FOIA email support be coordinated through your Program Office FOIA Coordinator to make it easier for everyone to keep track of all of the activities. I have been working with Patti Craver in NRR on many other requests and it would be much easier for everyone to have all of the requests come through her.

Also we currently cannot filter the email based on specific material in the messages or attachments. We can only pull the whole mailbox between specific dates and either provide someone a copy of it that they can work with or just try and PDF the whole mailbox and print everything out. I would suggest coordinating with Patti to determine exactly what you need and see if we can help you in any way.

Thanks!

Bob

From: Correia, Richard
Sent: Monday, April 18, 2011 7:13 AM

To: ICOD Support (FOIA); ICSupport Resource

Cc: Randall, Bob

Subject: FOIA support

ICOD, Bob,

I request your assistance with a FOIA that asks for "all documentation pertaining to the Japanese event during the period of March 11, 2011 through April 11, 2011". Specifically, I request your assistance with identifying and printing any email and their attachments under my account, Richard.Correia@NRC.GOV.

Please contact me should there be any questions.

Regards,

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

Coe, Doug

From: Flory, Shirley
Sent: Wednesday, April 20, 2011 4:09 PM
To: Rini, Brett; Ibarra, Jose; Rivera-Lugo, Richard; Ramirez, Annie; Case, Michael; Coe, Doug; Correia, Richard; Gibson, Kathy; Richards, Stuart; Sangimino, Donna-Marie; Scott, Michael; Sheron, Brian; Uhle, Jennifer; Valentin, Andrea
Subject: FW: EDO Alignment/Pre-briefs for Commission Meetings
Attachments: EDO Alignment. Prebriefs for CM Meetings.doc

From: Taylor, Renee
Sent: Wednesday, April 20, 2011 4:04 PM
To: Andersen, James; Ash, Darren; Blount, Tom; Boger, Bruce; Borchardt, Bill; Bowman, Adriane; Boyce, Thomas (OIS); Boyd, Lena; Brenda Ross; Buckley, Patricia; Cannady, Ashley; Carpenter, Cynthia; Casby, Marcia; Casto, Chuck; Cianci, Sandra; Cohen, Miriam; Collins, Elmo; Collins, Jay; Cooper, LaToya; Corley, Cherrie; Damiano, Debra; Dapas, Marc; Dean, Bill; Dubose, Sheila; EDO_ETAs; Evans, Michele; Flory, Shirley; Garland, Stephanie; Givvines, Mary; Greene, LaTosha; Grobe, Jack; Haney, Catherine; Hasan, Nasreen; Higginbotham, Tina; Holahan, Gary; Howard, Patrick; Johnson, Michael; Kelley, Corenthis; Landau, Mindy; Lee, Pamela; Leeds, Eric; Lockhart, Denise; Lubinski, John; Mamish, Nader; Matakas, Gina; Mayberry, Theresa; McClain, Nicole; McCrary, Cheryl; McCree, Victor; McGinty, Tim; Miles, Patricia; Miller, Charles; Mitchell, Matthew; Muessle, Mary; ODaniell, Cynthia; Owen, Lucy; Pederson, Cynthia; Penny, Melissa; Plisco, Loren; Quesenberry, Jeannette; Riddick, Nicole; Ronewicz, Lynn; Salus, Amy; Satorius, Mark; Scarbrough, Thomas; Schaeffer, James; Schumann, Stacy; Schwarz, Sherry; Sheron, Brian; Sprogeris, Patricia; Tannenbaum, Anita; Taylor, Renee; Terry, Leslie; Thomas, Loretta; Tomczak, Tammy; Uhle, Jennifer; Veltri, Debra; Virgilio, Martin; Walker, Dwight; Weber, Michael; Wiggins, Jim; Williams, Barbara; Zimmerman, Roy
Subject: EDO Alignment/Pre-briefs for Commission Meetings

Please reference the updated list attached and ensure that your calendar reflects the changes as needed.

Thank you,
Renee

YX/518

EDO ALIGNMENT/PRE-BRIEFS FOR COMMISSION MEETINGS

Updated: 04/20/11

04/28/11

(9:30 – 11:30)

Japanese Earthquake Status – Focus on Station Black-Out

EDO Alignment: 03/28/11 @ 3:00 pm
EDO Pre-brief: 04/14/11 @ 1:00 pm (Rescheduled from 10:00am)

05/03/11

(9:00 – 12:00)

Information Briefing on Emergency Preparedness

EDO Alignment: 04/07/11 @ 4:00 pm (Rescheduled from 1:00pm)
EDO Pre-brief: 04/25/11 @ 1:30 pm (Rescheduled from 04/18/11)

05/12/11

(9:30 – 11:30)

Task Force Review – 30 Day Quick Look Following the Events in Japan

EDO Alignment: 04/18/11 @ 4:00 pm (Rescheduled from 04/07/11)
(Joint meeting with 6/16 CM Alignment)
EDO Pre-brief: 05/05/11 @ 4:00 pm (Rescheduled from 05/02/11)

05/27/11

(9:00 – 12:00)

Briefing on Results of AARM

EDO Alignment: CANCELLED NOT NEEDED - 03/28/11 @ 3:00 pm
EDO Pre-brief: 05/12/11 @ 3:00 pm

06/02/11

(9:30 – 10:30)

Human Capital and EEO

EDO Alignment: 03/17/11 @ 1:00 pm
EDO Pre-brief: 05/19/11 @ 3:00 pm (Rescheduled from 05/04/11)

06/06/11

(10:00 – 12:00)

Potential Meeting w/ACRS

EDO Alignment: CANCELLED NOT NEEDED - 03/29/11 @ 4:00 pm

EDO Pre-brief: CANCELLED NOT NEEDED - 05/19/11 @ 3:00 pm

06/16/11

(9:30 – 11:30)

Task Force Review – 60 Day Quick Look Following the Events in Japan

**EDO Alignment: 04/18/11 @ 4:00 pm (Rescheduled from 04/07/11)
(Joint meeting with 5/12 CM Alignment)**

EDO Pre-brief: 06/02/11 @ 4:00 pm

07/12/11

(9:30 – 11:30)

Briefing on NRC Actions for Addressing the Integrated Regulatory Review Service Report

EDO Alignment: 05/17/11 @ 10:00 am

EDO Pre-brief: 06/30/11 @ 3:00 pm

07/19/11

(9:30 – 11:30)

Briefing on the Task Force Review of NRC Processes and Regulations Following the Events in Japan

EDO Alignment: 05/24/11 @ 10:00 am

EDO Pre-brief: 07/07/11 @ 4:00 pm

NOTE: Please be aware that this list is organized by the Commission meeting date. EDO Alignment meetings are generally scheduled approximately 60 days prior to the Commission meeting. EDO Pre-briefs are scheduled approximately 2 weeks prior to the Commission meeting. All meetings are scheduled based on the availability of the EDO/DEDOS calendars. All meetings are held in conference room O-17B4.

Greenwood, Carol

From: Gibson, Kathy
Sent: Thursday, April 21, 2011 9:04 AM
To: Armstrong, Kenneth; Santiago, Patricia; Lee, Richard
Subject: Fw: COMPARATIVE RISK ASSESSMENT: FUEL STORAGE IN SFP vs. DRY CASK
Attachments: Picture (Device Independent Bitmap); Kathy Halvey Gibson.vcf

My understanding was these meetings (SOARCA and SFP) were being scheduled back-to-back on Monday 10-11 and 11-12. Is this the case? I will not be here on Wed-Fri.

From: Flory, Shirley
To: Gibson, Kathy
Sent: Thu Apr 21 09:00:20 2011
Subject: FW: COMPARATIVE RISK ASSESSMENT: FUEL STORAGE IN SFP vs. DRY CASK

Pat had me schedule the SOARCA meeting for Monday, 10:00-11:00. She asked that I move the above meeting from 10:45-11:45 on Wednesday to 10:00-11:00 Wednesday since the SOARCA meeting was being moved to Monday.

Thanks - Shirley

From: Gibson, Kathy
Sent: Wednesday, April 20, 2011 6:46 PM
To: Flory, Shirley
Subject: RE: COMPARATIVE RISK ASSESSMENT: FUEL STORAGE IN SFP vs. DRY CASK

Isn't this supposed to be Monday, April 25 from 10-11?



<<Kathy Halvey Gibson.vcf>>

-----Original Appointment-----

From: Flory, Shirley
Sent: Wednesday, April 20, 2011 5:39 PM
To: Sheron, Brian; Esmaili, Hossein; Helton, Donald; Murphy, Andrew; Lee, Richard; Hogan, Rosemary; Coyne, Kevin; Gibson, Kathy; Scott, Michael; Correia, Richard; Coe, Doug; Case, Michael; Richards, Stuart; Tinkler, Charles; Santiago, Patricia; Armstrong, Kenneth
Cc: Uhle, Jennifer; Hudson, Daniel; Stutzke, Martin
Subject: COMPARATIVE RISK ASSESSMENT: FUEL STORAGE IN SFP vs. DRY CASK
When: Wednesday, April 27, 2011 10:00 AM-11:00 AM (GMT-05:00) Eastern Time (US & Canada).
Where: C- 5C19

Hossein: If this date/time does not work for you, please let me know and I will try again, but I would probably have to re-schedule to the week of May 2. I was trying to accommodate Brian's and Kathy's schedule. Mike S. is on travel all next week.

Thanks – Shirley

301-251-7400

YX/519

UPDATED per conversation with Pat. Saf 4/20

Coe, Doug

From: Rini, Brett
Sent: Thursday, April 21, 2011 9:20 AM
To: Case, Michael; Correia, Richard; Scott, Michael
Cc: Donaldson, Leslie; Dempsey, Heather; Coe, Doug; Richards, Stuart
Subject: FOIA E-mail for your review
Attachments: FOIA E-mail- BAR comments.docx

As discussed, here's the electronic version of the FOIA e-mail for your review. Please provide any comments to Heather Dempsey by Friday morning, so she can have Brian send it out in the afternoon.

Thanks,

Brett

From: Dempsey, Heather
Sent: Thursday, April 21, 2011 8:49 AM
To: Rini, Brett
Subject: FOIA E-mail- BAR comments.docx

Please forward to the managers for review.

YY/520

DRAFT: Personal note from Brian Sheron to All RES Staff

Greetings,

The agency has received an unusually high number of Freedom of Information Act (FOIA) requests over the past few weeks. Government employees are required to respond to these requests under FOIA. I acknowledge that you have other work and competing priorities, and you should not put aside mission-critical work to address a FOIA request. However, you must respond to these requests and produce all requested records in a timely fashion.

All staff and managers are responsible for providing the requested records (hard copies/ printed single sided), reviewing those records for any exemptions, (e.g. pre-decisional information, personally identifiable information, proprietary information, etc) and provide an estimate of time spent on requests to your Technical Assistant (TA). The TA will compile the division response and coordinate any issues with the Office FOIA coordinator. More information on the active FOIA requests for RES can be found at: <http://www.internal.nrc.gov/RES/FOIA/index.htm>.

There have been some concerns about expedited requests. Expedited processing does not mean that you put aside mission-related work in order to process these requests, but that you work on the expedited requests first before other requests.

Please contact your division TA and Office FOIA Coordinators: Jazel.Parks@nrc.gov (x7690) and Heather.Dempsey@nrc.gov (x7666) if you have any questions.

I appreciate your continued cooperation in this matter.

Coe, Doug

From: Correia, Richard
Sent: Thursday, April 21, 2011 12:19 PM
To: Coe, Doug
Subject: RE: FOIA E-mail for your review

Doug,

I feel your rewrite should be considered. I wouldn't recommend we ask for OGC approval but rather agreement that as managers we direct what work is to be done and on what schedules, including FOIAs in context of mission-related activities especially in light of the significant efforts needed to respond to the FOIAs.

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Coe, Doug
Sent: Thursday, April 21, 2011 12:11 PM
To: Correia, Richard
Subject: FW: FOIA E-mail for your review

Rich, this is the degree of detail our guidance needs, but I'm not sure Brian would be willing to use this without OGC approval. However, we already have told staff that the normal deadlines don't apply and that we only need to make reasonable progress. We are obligated to tell them what that means.

For the purpose of addressing FOIAs, mission-related work in RES means work that is driven by schedule commitments that are directed from outside of our Office. For example, Commission-directed and user need requested work are mission-related. Work in which RES has control over schedule and deadlines is not considered mission-related, for example, organizational improvement or external collaboration activities. Also, a reasonable level of effort is expected to be weekly progress involving a minimum of 3 hours of time per week, assuming you are in the office and that deadlines and quality of mission-related work will not be impacted. If exceptions to this guideline are needed, please request them through your management chain.

From: Rini, Brett
Sent: Thursday, April 21, 2011 9:20 AM
To: Case, Michael; Correia, Richard; Scott, Michael
Cc: Donaldson, Leslie; Dempsey, Heather; Coe, Doug; Richards, Stuart
Subject: FOIA E-mail for your review

As discussed, here's the electronic version of the FOIA e-mail for your review. Please provide any comments to Heather Dempsey by Friday morning, so she can have Brian send it out in the afternoon.

Thanks,

Brett

YY/521

From: Dempsey, Heather
Sent: Thursday, April 21, 2011 8:49 AM
To: Rini, Brett
Subject: FOIA E-mail- BAR comments.docx

Please forward to the managers for review.

Coe, Doug

From: Rini, Brett
Sent: Friday, April 22, 2011 12:12 PM
To: Sheron, Brian
Cc: Uhle, Jennifer; Correia, Richard; Case, Michael; Richards, Stuart; Coe, Doug; Gibson, Kathy; Scott, Michael; Dempsey, Heather; Parks, Jazel; Valentin, Andrea; Donaldson, Leslie
Subject: REPLY: FOIA E-mail for your review
Attachments: FOIA E-mail 4-22-11.docx

Brian,

Here is the FOIA e-mail for your review and for you to send to OIS and OGC prior to sending to the staff.

Heather did most of the work on the content, and all of the TAs and divisions provided comments.

Let me know how you want to proceed.

Thanks,

Brett

YX/522

DRAFT: Email from Brian Sheron to All RES Staff

Greetings,

The agency has received an unusually high number of Freedom of Information Act (FOIA) requests over the past few weeks. All government employees are required by law to respond to such requests. I acknowledge that you have other work and competing priorities, and you should not put aside mission-related work to address a FOIA request.

For the purpose of addressing FOIAs, mission-related work in RES means work that is driven by schedule commitments that are directed from outside of our Office. For example, Commission-directed and user need requested work are mission-related. Work in which RES has control over schedule and deadlines is not considered mission-related, for example, organizational improvement or external collaboration activities.

I ask that you make commit a reasonable level of effort each week to responding to these requests. A reasonable level of effort is considered weekly progress involving a minimum of 3 hours of time per week, assuming you are in the office and that deadlines and quality of mission-related work are not impacted. If exceptions to these guidelines are needed or if you need to work additional hours outside of your normal schedule, please discuss with your supervisor. Additionally, expedited processing does not mean that you put aside mission-related work in order to process these requests, but that you work on the expedited requests first before other requests.

All staff and managers are responsible for providing the requested records (hard copies/ printed single sided), reviewing those records for any exemptions, (e.g. pre-decisional information, personally identifiable information, proprietary information, etc) and providing an estimate of time spent on each request to your Technical Assistant (TA). The TA will compile the division response and coordinate any issues with the Office FOIA coordinator. More information on the active FOIA requests for RES can be found at: <http://www.internal.nrc.gov/RES/FOIA/index.htm>.

Please contact your division TA and Office FOIA Coordinators: Jazel.Parks@nrc.gov (x7690) and Heather.Dempsey@nrc.gov (x7666) if you have any questions.

I appreciate your continued cooperation in this matter and trust that you will do your part to increase the agencies transparency to the public.

Fleger, Stephen

From: Fleger, Stephen
Sent: Monday, April 25, 2011 7:44 AM
To: Correia, Richard; 'Persen'
Subject: Insights into TEPCO's Organizational Culture

Below is the newspaper article I was referring to last Thursday about a Japanese business man's offer to use concrete pumper trucks to provide cooling water to Fukushima's troubled reactors.

The Washington Post

Early disorder added to Japan's nuclear crisis

By Andrew Higgins, Tuesday, April 19, 10:40 PM

YOKKAICHI, Japan — When lead-lined Japanese military helicopters took to the sky last month to dump water onto the Fukushima Daiichi nuclear power station, Kazunori Hasegawa watched the desperate and highly risky cooling operation on television with dismay.

“It was so inefficient, so inefficient,” recalled Hasegawa, president of Chuo Construction. The Chinook helicopters had to fly high to avoid potentially lethal radiation, and much of the 8,000 gallons they dropped during the day's operation landed wide of the mark.

He had an idea: Might not two huge German-made contraptions he had sitting outside his office here in Yokkaichi do a better job? The devices, truck-mounted concrete pumps, had maneuverable arms 52 yards long and could blast water directly onto the Tokyo Electric Power Co.'s perilously overheated reactors and spent fuel rods.

“I was ready to move right away,” Hasegawa said. Tokyo Electric, known as Tepco, wasn't.

More than a month after he offered to help, his machines still hadn't been put to use. Instead, Tepco, with help from the Japanese government, brought in similar, albeit slightly longer, pump trucks from Germany, China and the United States. Two with especially long arms arrived by air from Los Angeles and Atlanta last week.

The episode illuminates some of the headaches that plagued Japan's critical early response to the world's biggest nuclear disaster since Chernobyl. Initially reluctant to acknowledge the gravity of the crisis, Tepco played down the danger as it struggled to keep pace with an escalating and ever-shifting catastrophe at the six-reactor Daiichi complex. The plant had been built to harness complex laws of nuclear physics, but the damage it suffered in the March 11 earthquake-generated tsunami generated a chaos of often mundane logistical problems involving trucks and pumps, fire and water.

A massive operation

44/523

Tepco, the world's largest private electric utility, supplied a third of Japan's electricity before the quake and has dozens of subsidiaries abroad, including a uranium producer in Canada, a company in Delaware and a shipping firm in the Bahamas. Its size, combined with a rigid top-down hierarchy and a commitment to proven procedure, made the company a steady pillar of Japan's corporate establishment but crimped its capacity for swift and innovative action.

When radiation spiked dramatically at its Daiichi plant on March 15 after an explosion at reactor unit 3 — one of several blasts at the complex — and the exposure of highly radioactive spent fuel rods, Japan's Self-Defense Forces sent helicopters to dump water scooped from the sea. An initial attempt on March 16 had to be aborted because radiation was just too high.

On the same day, at Tepco's Tokyo headquarters, the company's boss, Masataka Shimizu, vanished. His health cracking under the strain, he quit an emergency command center on the second floor and secluded himself in his office upstairs.

When the military helicopters tried again the following day, Hasegawa, Chuo Construction's chief, sat glued to his television like much of Japan. After watching a spray of water drift aimlessly toward the nuclear plant, he knew that every minute mattered.

The businessman contacted a local politician, Eikei Suzuki, who had contacts in Tokyo, and asked him to offer Chuo Construction's machinery for immediate use. It was early afternoon on March 17, just two days after radiation levels skyrocketed, and Japan teetered on the edge of a full-scale nuclear catastrophe.

Suzuki, who at the time was running for governor of Mie prefecture against the ruling party, got in touch with the Ministry of Economy, Trade and Industry in Tokyo and passed on Chuo Construction's offer. Suzuki used to work at the ministry, a big promoter of nuclear power and also the industry's regulator. Later the same day, the nuclear safety agency, which is under the ministry, called Chuo Construction: "Please wait awhile for a call from Tokyo Electric."

While Hasegawa waited, military fire trucks and police water cannons were called in to squirt water from a distance. They sometimes hit their target but released so much water that the crippled nuclear facility was soon awash with contaminated liquid.

Only last week did Tokyo acknowledge that radioactive material released in these early days made the disaster a level-7 event on an international scale, putting it on a par with Chernobyl. And it took until Sunday for Tepco to admit that cooling systems crippled by the tsunami were beyond repair and will have to be replaced. This and other work to halt radioactive emissions and bring the Fukushima Daiichi facility to a stable state will last six to nine months, the company announced.

Three full days after his initial offer, Hasegawa received a late-night call from Tepco asking him to send his machines as soon as possible. He dispatched them the same night. Tepco, however, then decided it would wait for the arrival of similar devices from elsewhere.

Noriyuki Shikata, deputy cabinet spokesman, confirmed that Chuo Construction offered its machinery on March 17 and said the offer was passed on to Tepco the same day. "Due to the situation," he added, "some loss of time" might have occurred, but this was because of "operational reasons" and the confusion attending Japan's gravest crisis since World War II.

A Tepco spokesman, Yoshimi Hitosugi, declined to comment on the utility's dealings with Chuo Construction. He said German- and Chinese-made pump trucks are now in use at the Daiichi plant but added that "it is

extremely difficult to confirm the process of how decisions for each individual activity were made on the ground.”

Concrete pump machines, said Hidehiko Nishiyama, deputy head of Japan’s nuclear safety agency, are “more precise” than the helicopters and fire hoses that were initially deployed. He said the concrete pumps had been used “as soon as possible after they were offered.” Asked about Tepco’s delay in responding to Chuo Construction, he replied: “It is a *big* company.”

Stops and starts

The government, for its part, moved more swiftly to embrace the idea of using concrete pumps, though not those offered by Hasegawa. A day after the construction boss first made his suggestion, a deputy chief cabinet secretary met with the local boss of Putzmeister, a German company that manufactured the two machines owned by Chuo Construction.

Putzmeister had no experience in cooling overheated fuel rods, but one of its machines had been used in a 1986 operation to seal the doomed reactor at Chernobyl. Hiroshi Suzuki, Putzmeister’s Japan chief, took along a model of a truck-mounted concrete pump and explained that such devices could perhaps be used to fire water into the nuclear plant.

“They reacted quickly,” recalled Suzuki, who was asked whether his company could divert a pump truck then en route from Germany to Vietnam via Japan for use at the Daiichi plant. On March 20, the pump started moving toward Fukushima prefecture from Yokohama Port near Tokyo, but trouble with the machinery brought the truck to a stop.

At 10 p.m. the same day, Tepco finally called Hasegawa and asked him to send his own machines: “We need your help now!” Hasegawa recalls being told. His two pump vehicles set off on a 320-mile journey and, the following morning, reached a Tepco facility in Onahama, about 30 miles south of Fukushima Daiichi. Instead of carrying on to the nuclear plant, however, they were told to wait.

There had been a change of plan: The machine originally destined for Vietnam had been repaired and was back on the road. It started working at the nuclear plant on March 22. A second machine, also manufactured by Putzmeister, arrived from central Japan a few days later.

Still waiting

In the weeks since, Tepco, with help from the Japanese government and Putzmeister, has scoured the world for concrete pump trucks. Chuo Construction’s machines, though the first to arrive in the vicinity of the nuclear plant, sat waiting.

Hasegawa, Chuo Construction’s boss, takes some satisfaction from the fact that his idea, if not his machinery, has become a key part of emergency cooling efforts at the Daiichi plant. But he says he remains mystified by the holdup. One explanation, he says, might be that the government and Tepco “wanted to sort out this problem by themselves.”

© 2011 The Washington Post Company

Ibarra, Jose

From: Correia, Richard
Sent: Tuesday, April 26, 2011 4:09 PM
To: Ibarra, Jose
Subject: RE: ACTION: Two New FOIA Requests from Greenwire & Natural Resource Defense Council

Sure Jose...once I get the documents.

Thx!

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Ibarra, Jose
Sent: Tuesday, April 26, 2011 4:03 PM
To: Correia, Richard
Subject: RE: ACTION: Two New FOIA Requests from Greenwire & Natural Resource Defense Council

Rich,
Can I help you? I may have time to review and mark your documents. Jose

From: Correia, Richard
Sent: Tuesday, April 26, 2011 4:01 PM
To: Ibarra, Jose
Subject: RE: ACTION: Two New FOIA Requests from Greenwire & Natural Resource Defense Council

Jose,

I am waiting for the printed documents from OIS for the Kyodo FOIA. I do not know if they will be here and I will have sufficient time to review them before May 2.

Richard Correia, PE
Director, Division of Risk Analysis
Office of Nuclear Regulatory Research
US NRC

richard.correia@nrc.gov

From: Ibarra, Jose
Sent: Tuesday, April 26, 2011 3:57 PM
To: RES_DRA
Subject: ACTION: Two New FOIA Requests from Greenwire & Natural Resource Defense Council

DRA Staff,

All RES divisions have been task with two (2) new FOIA Requests from Greenwire (Expedited Processing) & the Natural Resource Defense Council (NRDC).

YX/524

Please provide **ALL** documentation (This includes all e-mails, faxes, written correspondences, meeting minutes, memos, studies, analyses, etc.) pertaining to the Japanese events **during the period of March 11th through April 20th, 2011.**

Instructions for the Greenwire & NRDC FOIA requests:

1. If you already submitted your records for the previous FOIA requests listed below, you **DO NOT need to re-submit the records for the dates that were covered by those requests.**
 - AP FOIA: March 11 - 16, 2011
 - Greenpeace FOIA: March 11 - 24, 2011
 - Kyodo News FOIA: March 11 – April 11, 2011
2. For e-mail records, **provide only the communications that you have sent addressing the Japanese events (Sent folder).** You only have to provide items from your inbox (received e-mails) if they were sent by any person, organization or agency outside of NRC. See the attached FOIAs.
3. The FOIA Office has requested the staff to submit all records in **hard copies, printed single-sided.**
4. **Make sure to mark in your records any exemptions that might apply to information that, in your opinion, should not be released to the public** (e.g. pre-decisional information, personal identifiable information, proprietary information, etc). Please follow the guidance on the "*How to Respond to a FOIA Request*" document. A "Quick Reference to FOIA Exemptions" is attached for your convenience.
5. Along with your records package, **include a sheet with your name, time spent responding to this FOIA request, and a note indicating if your submission of records is partial or final.** Packages should be dropped off at the "DE's FOIA Corner" located in front of Mike Case's office (CSB-5 A05).

More information on the active FOIA requests for RES can be found accessing the link below.
<http://www.internal.nrc.gov/RES/FOIA/index.htm>

Please use TAC# **ZF0001** to record your time in HRMS related to activities in response to a FOIA request.

Provide hard copies only of any records that meet the above criteria by 1:00 PM on Monday, May 2nd.

If you have any questions please contact me or Jazel Parks, and we will do our best to address your concerns.

Thanks,
Jose

Coe, Doug

From: Case, Michael
Sent: Wednesday, April 27, 2011 7:21 AM
To: Correia, Richard; Coe, Doug; Gibson, Kathy; Scott, Michael
Cc: Hiland, Patrick
Subject: FW: Updated RST Watch Bill as of 1500 on Tuesday April 26th
Attachments: RST Watch Bill as of 04-26-11 at 1500.pdf

Hi folks. Pat asked if I would drum up some support for filling the gaps in the RST watchbill. I think our folks would be particularly useful for the position called Accident Analyst. I wouldn't overly read in too much to the title. The role is more of a support position to the BWR expert. Any serious "analysis" activity is now just assigned to the line office. I've been asking all my folks that have previously participated in other roles in the Ops Center to try and pick up some shifts.

Thanks for your support!

From: Hasselberg, Rick
Sent: Tuesday, April 26, 2011 3:06 PM
To: Alter, Peter; Hiland, Patrick; Brown, Frederick; Skeen, David; Dudes, Laura; Ruland, William; Case, Michael; Uhle, Jennifer; Holian, Brian; Hackett, Edwin; Howe, Allen; Richards, Stuart; Kotzalas, Margie; Rini, Brett; Bukharin, Oleg; Thomas, Eric; Berry, Rollie; Belen, Aixa; Williams, Joseph; Boyce, Tom (RES); Flanagan, Michelle; Starefos, Joelle; Kavanagh, Kerri; Orr, Mark; Collins, Frank; Schoenebeck, Greg; Morlang, Gary; Dion, Jeanne; Sloan, Scott; McGovern, Denise; Circle, Jeff; Esmaili, Hossein; Cheok, Michael; Ward, Leonard; Laur, Steven; Salay, Michael; Schaperow, Jason; Fuller, Edward; Marksberry, Don; Lane, John; Gilmer, James; Dube, Donald; Miranda, Samuel; Arndt, Steven; Helton, Donald; Dozier, Jerry; Skarda, Raymond; Howe, Andrew; Mitman, Jeffrey; Harrison, Donnie; Chung, Donald; Koshy, Thomas; Zoulis, Antonios; Gavrilas, Mirela; Wong, See-Meng; Beasley, Benjamin; Marshall, Donald; Velazquez-Lozada, Alexander; Iyengar, Raj; Criscione, Lawrence; Caruso, John; Phan, Hanh; Brown, Eva; Brown, Michael; Norton, Charles; Cranston, Gregory; Kolb, Timothy; Vick, Lawrence; Shea, James; Summers, Robert; Gulla, Gerald; Kauffman, John; Hart, Ken; Bloom, Steven; Padovan, Mark; Williams, Donna; Isom, James; Thorp, John; Kugler, Andrew; Roggenbrodt, William; Gardocki, Stanley; Jervey, Richard; Horn, Brian; Ramadan, Liliana; Thompson, Jon; Solorio, Dave; Reeves, Rosemary; Ghosh, Tina; Arildsen, Jesse; Campbell, Stephen; Kauffman, John; Vick, Lawrence; Brown, Eva; Brown, Michael; Summers, Robert; Alter, Peter; Gulla, Gerald; Shea, James; Cranston, Gregory; Marksberry, Don; Scales, Kerby; Harrison, Donnie; Drozd, Andrzej; Karipineni, Nageswara; Cusumano, Victor
Cc: Dozier, Jerry; Gray, Kathy; Grant, Jeffery; Thomas, Eric; RST01 Hoc; Ibarra, Jose
Subject: Updated RST Watch Bill as of 1500 on Tuesday April 26th

All,

Please review the attached watch bill. If you can support an additional shift or two, please let us know. These are still tough times.

Please continue to notify me and Jerry Dozier if you need to make changes. I intend to publish the next watch bill sometime tomorrow afternoon. Thanks.

This is still a top Agency priority. Management will soon be asked to fill shifts for which we do not have volunteers. So, thanks so much!

Rick

Rick Hasselberg
Sr. Emergency Response Coordinator
NRC Reactor Safety Team
Office of Nuclear Security and Incident Response
M/S T-4A43

44/525

03-13 to 05-15 Complete RST Watch Bill as of 04-26-11 at 1500.xlsx

<u>Date</u>	<u>Day</u>	<u>Time</u>	<u>Shift</u>	<u>Accident Analyst</u>	<u>BWR Expert</u>
04/26/2011	Tuesday	0700 - 1500	Day	Don Dube	Steven Campbell
04/26/2011	Tuesday	1500 - 2300	Swing	Steven Arndt	Chuck Norton
04/26/2011	Tuesday	2300- 0700	Midnight	Andrzej Drozd	Kerby Scales
04/27/2011	Wednesday	0700 - 1500	Day	Tom Koshy	Mike Brown
04/27/2011	Wednesday	1500 - 2300	Swing	Steven Arndt	Andy Kugler
04/27/2011	Wednesday	2300- 0700	Midnight	See-Meng Wong	Eva Brown
04/28/2011	Thursday	0700 - 1500	Day	Donnie Harrison	Mike Brown
04/28/2011	Thursday	1500 - 2300	Swing	Raj Iyengar	Andy Kugler
04/28/2011	Thursday	2300- 0700	Midnight	TBD	Eva Brown
04/29/2011	Friday	0700 - 1500	Day	Donnie Harrison	Larry Vick
04/29/2011	Friday	1500 - 2300	Swing	Tom Koshy	Andy Kugler
04/29/2011	Friday	2300- 0700	Midnight	TBD	Eva Brown
04/30/2011	Saturday	0700 - 1500	Day	Raj Iyengar	Larry Vick
04/30/2011	Saturday	1500 - 2300	Swing	See-Meng Wong	Andy Kugler
04/30/2011	Saturday	2300- 0700	Midnight	TBD	Eva Brown
05/01/2011	Sunday	0700 - 1500	Day	Raj Iyengar	Larry Vick
05/01/2011	Sunday	1500 - 2300	Swing	Ray Skarda	Andy Kugler
05/01/2011	Sunday	2300- 0700	Midnight	See-Meng Wong	Eva Brown
05/02/2011	Monday	0700 - 1500	Day	Don Algama	Tim Kolb
05/02/2011	Monday	1500 - 2300	Swing	Ray Skarda	TBD
05/02/2011	Monday	2300- 0700	Midnight		Rao Karipineni
05/03/2011	Tuesday	0700 - 1500	Day		Tim Kolb
05/03/2011	Tuesday	1500 - 2300	Swing	Ray Skarda	Chuck Norton
05/03/2011	Tuesday	2300- 0700	Midnight		Rao Karipineni
05/04/2011	Wednesday	0700 - 1500	Day		Mike Brown
05/04/2011	Wednesday	1500 - 2300	Swing	Ray Skarda	Chuck Norton
05/04/2011	Wednesday	2300- 0700	Midnight	See-Meng Wong	Rao Karipineni
05/05/2011	Thursday	0700 - 1500	Day		Mike Brown
05/05/2011	Thursday	1500 - 2300	Swing	Hanh K Phan	Chuck Norton
05/05/2011	Thursday	2300- 0700	Midnight		TBD
05/06/2011	Friday	0700 - 1500	Day	Larry Criscione	Tim Kolb
05/06/2011	Friday	1500 - 2300	Swing	Hanh K Phan	Steven Campbell
05/06/2011	Friday	2300- 0700	Midnight		Eva Brown

03-13 to 05-15 Complete RST Watch Bill as of 04-26-11 at 1500.xlsx

<u>Date</u>	<u>Day</u>	<u>Time</u>	<u>Shift</u>	<u>Accident Analyst</u>	<u>BWR Expert</u>
05/07/2011	Saturday	0700 - 1500	Day	Larry Criscione	Larry Vick
05/07/2011	Saturday	1500 - 2300	Swing	Raj Iyengar	Steven Campbell
05/07/2011	Saturday	2300- 0700	Midnight	See-Meng Wong	Eva Brown
05/08/2011	Sunday	0700 - 1500	Day	Larry Criscione	Larry Vick
05/08/2011	Sunday	1500 - 2300	Swing	Raj Iyengar	TBD
05/08/2011	Sunday	2300- 0700	Midnight		Eva Brown
05/09/2011	Monday	0700 - 1500	Day		Tim Kolb
05/09/2011	Monday	1500 - 2300	Swing	Antonios Zoulis	TBD
05/09/2011	Monday	2300- 0700	Midnight	See-Meng Wong	TBD
05/10/2011	Tuesday	0700 - 1500	Day		Tim Kolb
05/10/2011	Tuesday	1500 - 2300	Swing	Antonios Zoulis	TBD
05/10/2011	Tuesday	2300- 0700	Midnight		TBD
05/11/2011	Wednesday	0700 - 1500	Day		TBD
05/11/2011	Wednesday	1500 - 2300	Swing	Antonios Zoulis	TBD
05/11/2011	Wednesday	2300- 0700	Midnight	See-Meng Wong	TBD
05/12/2011	Thursday	0700 - 1500	Day		TBD
05/12/2011	Thursday	1500 - 2300	Swing	Antonios Zoulis	TBD
05/12/2011	Thursday	2300- 0700	Midnight		TBD
05/13/2011	Friday	0700 - 1500	Day	Raj Iyengar	Tim Kolb
05/13/2011	Friday	1500 - 2300	Swing	Antonios Zoulis	TBD
05/13/2011	Friday	2300- 0700	Midnight	Larry Criscione	Eva Brown
05/14/2011	Saturday	0700 - 1500	Day	Raj Iyengar	Larry Vick
05/14/2011	Saturday	1500 - 2300	Swing		TBD
05/14/2011	Saturday	2300- 0700	Midnight	Larry Criscione	Eva Brown
05/15/2011	Sunday	0700 - 1500	Day	See-Meng Wong	Larry Vick
05/15/2011	Sunday	1500 - 2300	Swing	Raj Iyengar	TBD
05/15/2011	Sunday	2300- 0700	Midnight	Larry Criscione	Eva Brown

as of 4/26/11 1500

Position "On-Call" from 15:00 on Friday 4/22/11 until 23:00 on Sunday 4/24/11.

Indicates a change since last RST watchbill was issued.

<u>Date</u>	<u>Day</u>	<u>Time</u>	<u>Shift</u>	<u>Accident Analyst</u>	<u>BWR Expert</u>
-------------	------------	-------------	--------------	-------------------------	-------------------

TBD *Indicates position is not presently filled with a qualified watchstander.*

03-13 to 05-15 Complete RST Watch Bill as of 04-26-11 at 1500.xlsx

<u>Date</u>	<u>Day</u>	<u>Time</u>	<u>Shift</u>	<u>Accident Analyst</u>	<u>BWR Expert</u>
04/26/2011	Tuesday	0700 - 1500	Day	Don Dube	Steven Campbell
04/26/2011	Tuesday	1500 - 2300	Swing	Steven Arndt	Chuck Norton
04/26/2011	Tuesday	2300- 0700	Midnight	Andrzej Drozd	Kerby Scales
04/27/2011	Wednesday	0700 - 1500	Day	Tom Koshy	Mike Brown
04/27/2011	Wednesday	1500 - 2300	Swing	Steven Arndt	Andy Kugler
04/27/2011	Wednesday	2300- 0700	Midnight	See-Meng Wong	Eva Brown
04/28/2011	Thursday	0700 - 1500	Day	Donnie Harrison	Mike Brown
04/28/2011	Thursday	1500 - 2300	Swing	Raj Iyengar	Andy Kugler
04/28/2011	Thursday	2300- 0700	Midnight	TBD	Eva Brown
04/29/2011	Friday	0700 - 1500	Day	Donnie Harrison	Larry Vick
04/29/2011	Friday	1500 - 2300	Swing	Tom Koshy	Andy Kugler
04/29/2011	Friday	2300- 0700	Midnight	TBD	Eva Brown
04/30/2011	Saturday	0700 - 1500	Day	Raj Iyengar	Larry Vick
04/30/2011	Saturday	1500 - 2300	Swing	See-Meng Wong	Andy Kugler
04/30/2011	Saturday	2300- 0700	Midnight	TBD	Eva Brown
05/01/2011	Sunday	0700 - 1500	Day	Raj Iyengar	Larry Vick
05/01/2011	Sunday	1500 - 2300	Swing	Ray Skarda	Andy Kugler
05/01/2011	Sunday	2300- 0700	Midnight	See-Meng Wong	Eva Brown
05/02/2011	Monday	0700 - 1500	Day	Don Algama	Tim Kolb
05/02/2011	Monday	1500 - 2300	Swing	Ray Skarda	TBD
05/02/2011	Monday	2300- 0700	Midnight		Rao Karipineni
05/03/2011	Tuesday	0700 - 1500	Day		Tim Kolb
05/03/2011	Tuesday	1500 - 2300	Swing	Ray Skarda	Chuck Norton
05/03/2011	Tuesday	2300- 0700	Midnight		Rao Karipineni
05/04/2011	Wednesday	0700 - 1500	Day		Mike Brown
05/04/2011	Wednesday	1500 - 2300	Swing	Ray Skarda	Chuck Norton
05/04/2011	Wednesday	2300- 0700	Midnight	See-Meng Wong	Rao Karipineni
05/05/2011	Thursday	0700 - 1500	Day		Mike Brown
05/05/2011	Thursday	1500 - 2300	Swing	Hanh K Phan	Chuck Norton
05/05/2011	Thursday	2300- 0700	Midnight		TBD
05/06/2011	Friday	0700 - 1500	Day	Larry Criscione	Tim Kolb
05/06/2011	Friday	1500 - 2300	Swing	Hanh K Phan	Steven Campbell
05/06/2011	Friday	2300- 0700	Midnight		Eva Brown

03-13 to 05-15 Complete RST Watch Bill as of 04-26-11 at 1500.xlsx

<u>Date</u>	<u>Day</u>	<u>Time</u>	<u>Shift</u>	<u>Accident Analyst</u>	<u>BWR Expert</u>
05/07/2011	Saturday	0700 - 1500	Day	Larry Criscione	Larry Vick
05/07/2011	Saturday	1500 - 2300	Swing	Raj Iyengar	Steven Campbell
05/07/2011	Saturday	2300- 0700	Midnight	See-Meng Wong	Eva Brown
05/08/2011	Sunday	0700 - 1500	Day	Larry Criscione	Larry Vick
05/08/2011	Sunday	1500 - 2300	Swing	Raj Iyengar	TBD
05/08/2011	Sunday	2300- 0700	Midnight		Eva Brown
05/09/2011	Monday	0700 - 1500	Day		Tim Kolb
05/09/2011	Monday	1500 - 2300	Swing	Antonios Zoulis	TBD
05/09/2011	Monday	2300- 0700	Midnight	See-Meng Wong	TBD
05/10/2011	Tuesday	0700 - 1500	Day		Tim Kolb
05/10/2011	Tuesday	1500 - 2300	Swing	Antonios Zoulis	TBD
05/10/2011	Tuesday	2300- 0700	Midnight		TBD
05/11/2011	Wednesday	0700 - 1500	Day		TBD
05/11/2011	Wednesday	1500 - 2300	Swing	Antonios Zoulis	TBD
05/11/2011	Wednesday	2300- 0700	Midnight	See-Meng Wong	TBD
05/12/2011	Thursday	0700 - 1500	Day		TBD
05/12/2011	Thursday	1500 - 2300	Swing	Antonios Zoulis	TBD
05/12/2011	Thursday	2300- 0700	Midnight		TBD
05/13/2011	Friday	0700 - 1500	Day	Raj Iyengar	Tim Kolb
05/13/2011	Friday	1500 - 2300	Swing	Antonios Zoulis	TBD
05/13/2011	Friday	2300- 0700	Midnight	Larry Criscione	Eva Brown
05/14/2011	Saturday	0700 - 1500	Day	Raj Iyengar	Larry Vick
05/14/2011	Saturday	1500 - 2300	Swing		TBD
05/14/2011	Saturday	2300- 0700	Midnight	Larry Criscione	Eva Brown
05/15/2011	Sunday	0700 - 1500	Day	See-Meng Wong	Larry Vick
05/15/2011	Sunday	1500 - 2300	Swing	Raj Iyengar	TBD
05/15/2011	Sunday	2300- 0700	Midnight	Larry Criscione	Eva Brown

as of 4/26/11 1500

Position "On-Call" from 15:00 on Friday 4/22/11 until 23:00 on Sunday 4/24/11.

Indicates a change since last RST watchbill was issued.

<u>Date</u>	<u>Day</u>	<u>Time</u>	<u>Shift</u>	<u>Accident Analyst</u>	<u>BWR Expert</u>
-------------	------------	-------------	--------------	-------------------------	-------------------

TBD *Indicates position is not presently filled with a qualified watchstander.*

Coe, Doug

From: Ibarra, Jose
Sent: Monday, April 25, 2011 10:02 AM
To: Beasley, Benjamin; Salley, MarkHenry; Peters, Sean; Ott, William; Demoss, Gary; Coyne, Kevin
Cc: Correia, Richard; Coe, Doug
Subject: Two More FOIAs on Japanese Event

All,
This is to let you know of two more FOIAs that I received today on the Japanese Event. One FOIA is from Greenwire, a media company, and the other FOIA is from the Natural Resources Defense Council, an activist group. The Greenwire FOIA was granted expedited processing. I will be sending these requests out tomorrow at which time I will provide all the information that I have on the FOIA. Thanks. Jose

XY/526

Coe, Doug

From: Sheron, Brian
Sent: Monday, April 25, 2011 12:42 PM
To: Rini, Brett; Case, Michael; Coe, Doug; Correia, Richard; Gibson, Kathy; Richards, Stuart; Scott, Michael; Uhle, Jennifer; Valentin, Andrea
Subject: FW: Establishment of FOIA Response Task Force

Brett, can you take the lead for RES?

From: Boyce, Thomas (OIS)
Sent: Friday, April 22, 2011 4:58 PM
To: Johnson, Michael; Leeds, Eric; Sheron, Brian; Vietti-Cook, Annette; Haney, Catherine; Brenner, Eliot; Schmidt, Rebecca; Doane, Margaret; Morris, Scott; Carpenter, Cynthia; Burns, Stephen
Cc: Nichols, Russell; Janney, Margie; Marshall, Jane; Holonich, Joseph; Schaeffer, James; Sealing, Donna; Akstulewicz, Brenda; Andersen, James; Bellosi, Susan; Belmore, Nancy; Boyd, Lena; Buckley, Patricia; Casby, Marcia; Cianci, Sandra; Crawford, Carrie; Flory, Shirley; Garland, Stephanie; Higginbotham, Tina; Hudson, Sharon; Landau, Mindy; Matakas, Gina; Miles, Patricia; Pulley, Deborah; Rihm, Roger; Riner, Janet; Ronewicz, Lynn; Ross, Robin; Salus, Amy; Tannenbaum, Anita; Taylor, Renee; Thomas, Loretta; Walker, Dwight; Warner, MaryAnn; Wright, Darlene; Wyatt, Melissa; Cannady, Ashley; Lockhart, Denise; Perez-Ortiz, Aracelis; Riddick, Nicole; King, Shannon; Penny, Melissa; Sprogeris, Patricia; Banks, Eleasah; Nagel, Cheri; Hasan, Nasreen; Call, Michel; Thaggard, Mark; Young, Gary; Moore, Mary; Daniels, Stanley; Kreuter, Jane; Schumann, Stacy; Rihm, Roger; Schwarz, Sherry; Ellmers, Glenn; Ash, Darren; Boger, Bruce; Brenner, Eliot; Brown, Milton; Burns, Stephen; Carpenter, Cynthia; Casto, Chuck; Cohen, Miriam; Collins, Elmo; Dapas, Marc; Dean, Bill; Doane, Margaret; Droggitis, Spiros; Dyer, Jim; Greene, Kathryn; Grobe, Jack; Hackett, Edwin; Haney, Catherine; Hayden, Elizabeth; Holahan, Gary; Howard, Patrick; Johnson, Michael; Kelley, Corenthis; Leeds, Eric; Mamish, Nader; McCrary, Cheryl; McCree, Victor; Miller, Charles; Moore, Scott; Pederson, Cynthia; Plisco, Loren; Poole, Brooke; Powell, Amy; Reyes, Luis; Satorius, Mark; Schaeffer, James; Schmidt, Rebecca; Sheron, Brian; Stewart, Sharon; Uhle, Jennifer; Virgilio, Martin; Weber, Michael; Wiggins, Jim; Williams, Barbara; Zimmerman, Roy; Campbell, Andy; Holahan, Patricia; Dorman, Dan; Muessle, Mary; Wert, Leonard; Tracy, Glenn; Taylor, Renee; Krupnick, David; Evans, Michele; Moore, Scott; Campbell, Andy; Holahan, Patricia
Subject: Establishment of FOIA Response Task Force

As noted in my earlier e-mail, I am reaching out to specific offices (NRR, RES, FSME, OPA, OCA, EDO, OIP, SECY, NRO, OGC and NMSS) to assist NRC in developing a global response to the recent FOIA request the Agency has received regarding the events in Japan, rather than treat them in the usual case-by-case manner.

As part of the effort to consolidate as many of these FOIA requests as possible, NRC is standing up a Task Force (TF) to review the identified records, and determine which information is releasable under FOIA, and to expedite the review process, to the extent possible. NSIR will provide a project manager and staff for the TF, OIS will provide a FOIA expert and an IT project manager as part of the TF. Your office is requested to support the FOIA TF by dedicating a staff member familiar with the technical information in your area that may be covered under the FOIA request(s). These staff should be a subject matter expert in order to recommend what should be denied or released, and assist in appropriately categorizing the information in response to the FOIA(s). OGC is requested to provide an attorney with FOIA expertise. The TF is expected to run for several months, and will take varying levels of effort during that time from initially near full time to half time or less later in the process. Staff assigned to the TF will need to be available to support the TF *ahead* of their regular assignments.

Once the TF is formed, OIS will provide additional training to its members on FOIA processes and exemptions. In addition, OIS is identifying and will obtain technologies to assist in searching for duplicate records electronically and to help identify information that could be exempt from disclosure. Having these automated processes is expected to help reduce the volume of information that the staff needs to review.

Offices that are currently working on the specific FOIA requests that the TF will review will be notified once the TF is assembled and should include those efforts as part of the TF to ensure consistency across the agency. Until then, staff

should continue to identify information that is needed to response to the FOIA requests, but the TF will review that information to identify what information can be withheld from release under FOIA. Jane Marshall, NSIR is coordinating the list of individuals working on the task force.

Thomas Boyce
Acting Deputy Executive Director for Corporate Management
US Nuclear Regulatory Commission
301-415-8700

Fleger, Stephen

From: George Ballassi [gballass@gdeb.com]
Sent: Monday, April 25, 2011 1:15 PM
To: am@nei.org; channas@westinghouse.com; d.t.goodney@ieee.org; dah@adventengineering.com; dennis.dellinger@ametek.com; dfb4@pge.com; djzaprazny@pplweb.com; dlgladey@pplweb.com; Dirk.hopp@areva.com; faroukbax@gmail.com; fuldrb@westinghouse.com; gballass@gdeb.com; george.attarian@pgnmail.com; geschinzel@stpegs.com; h.c.leake@ieee.org; harmond@westinghouse.com; ljaz.ahmad@luminant.com; j.d.macdonald@ieee.org; j.e.stoner@ieee.org; j.p.carter@ieee.org; jim.gleason@glseq.com; jthomas@mpr.com; jliming@absconsulting.com; John.Disosway@dom.com; Julius.Persensky@inl.gov; keith.bush@shawgrp.com; malcolms@aecl.ca; mark.f.santschi@sargentlundy.com; masafumi_utsumi@mhi.co.jp; mdbowman@ieee.org; Mansoor.h.sanwarwalla@sargentlundy.com; Michael.H.Miller@sargentlundy.com; Waterman, Michael; nmb@ieee.org; Nissen.Burstein@areva.com; parellj@westinghouse.com; pjohnso@entergy.com; r.c.carruth@ieee.org; r.j.fletcher@ieee.org; rehtec@optonline.net; robert.francis@wyle.com; Beacom, Royce; sa@ieee.org; Aggarwal, Satish; Fleger, Stephen; tengler@stevenson.cz; texasriccios@yahoo.com; Koshy, Thomas; Koshy, Thomas; YanosyPL@westinghouse.com
Subject: Fw: Japan METI Assessment Report <<Not-Sensitive>>
Attachments: METI Assessmnet April 2011.pdf

George A. Ballassi, Principal Eng

Electric Boat Corp, Groton, CT

(860) 433-3389

gballass@ebmail.gdeb.com

----- Forwarded by George Ballassi/EB/GDYN on 04/25/2011 01:14 PM -----

From: "Brosnan, Dan" <DFB4@pge.com>
To: "Shoulders, Jack" <JAS2@PGE.COM>, "Hendry, Bruce G" <BNH8@PGE.COM>, "George Ballassi" <gballass@gdeb.com>
Cc: "Vernon Pruett" <vpruett@pacbell.net>
Date: 04/25/2011 01:01 PM
Subject: FW: Japan METI Assessment Report

From: Jeff Skov [mailto:jskov@VALHI.NET]
Sent: Monday, April 25, 2011 9:30 AM
To: Brosnan, Dan
Subject: FW: Japan METI Assessment Report

44/528

Fyi.

From: Charles Haughney [<mailto:cjhaughney@mac.com>]

Sent: Monday, April 25, 2011 10:26 AM

To: YMP Faithful

Subject: Japan METI Assessment Report

Japan's Challenges

Concerning the Domestic and International Implications
of Fukushima Dai-ichi Nuclear Power Station

April 2011

Ministry of Economy, Trade and Industry

Table of Contents

A. Japan Faces an Unprecedented Challenge *(Enormous Earthquake, Tsunamis and Nuclear Accident)*

1. Damage
2. Rescue Efforts and Foreign Assistance
3. Nuclear Power Stations

B. Key Challenges

1. Cool Down the Reactors
2. Contain the Spread of Radioactive Substances (sea, soil and atmosphere)
3. Rigorous and Intensive Monitoring
4. Ensure the Safety of Food, Drinking Water, On-site Workers, Industrial Products, Ports and Airports

C. Impact on Japanese Economy

1. Estimated Economic Damage of the Tohoku-Pacific Ocean Earthquake and Plan for Reconstruction
2. Impact on Energy Supply/Demand in Japan

D. Information sharing and cooperation with the international community

1. Cooperation with International Organizations
2. Speedy Dissemination of Accurate Information

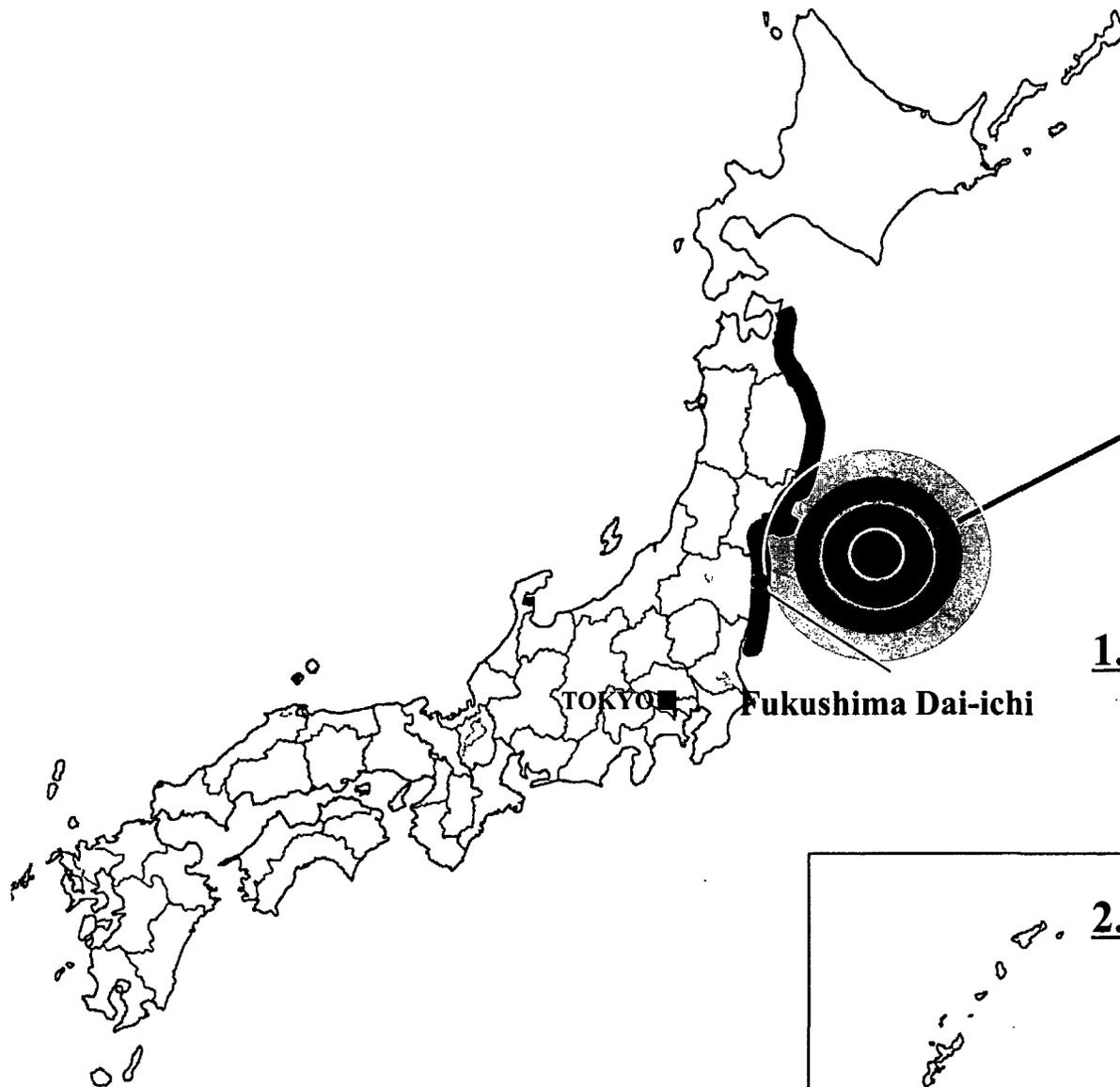
A. Japan Faces an Unprecedented Challenge

(Enormous Earthquake, Tsunamis and Nuclear Accident)

1. Damage
2. Rescue Efforts and Foreign Assistance
3. Nuclear Power Stations

A. Japan Faces an Unprecedented Challenge

(Enormous Earthquake, Tsunamis and Nuclear Accident)



Earthquakes:

M - 9.0 quake (March 11)
M - 7 class 5 times
M - 6 class 72 times
M - 5 class 423 times

1. Casualties : over 27,000

Dead	over 13,000
Missing	over 14,000

2. Evacuees : over 136,000

(As of April 17th)

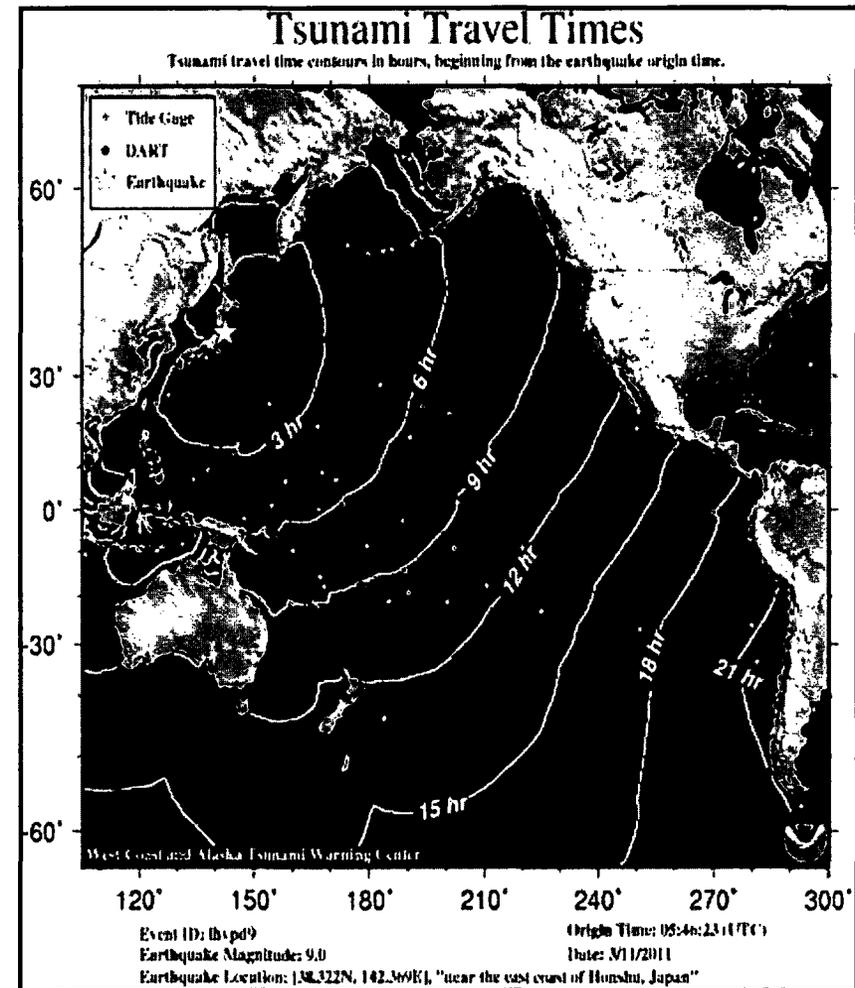
1. Damage



KYODO NEWS

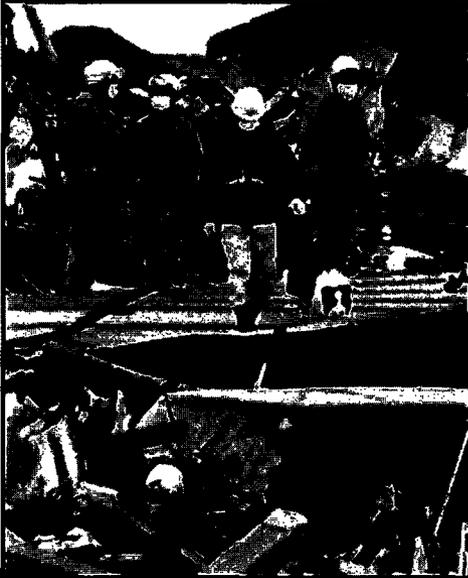


KYODO NEWS



NOAA/US Dept of Commerce, <http://wcatwc.arh.noaa.gov/>

2. Rescue Efforts and Foreign Assistance



Japan deeply appreciates the assistance offered from
142 countries and regions and
39 international organizations
(Rescue teams were sent from 24 countries, regions and
international organizations)

KYODO NEWS



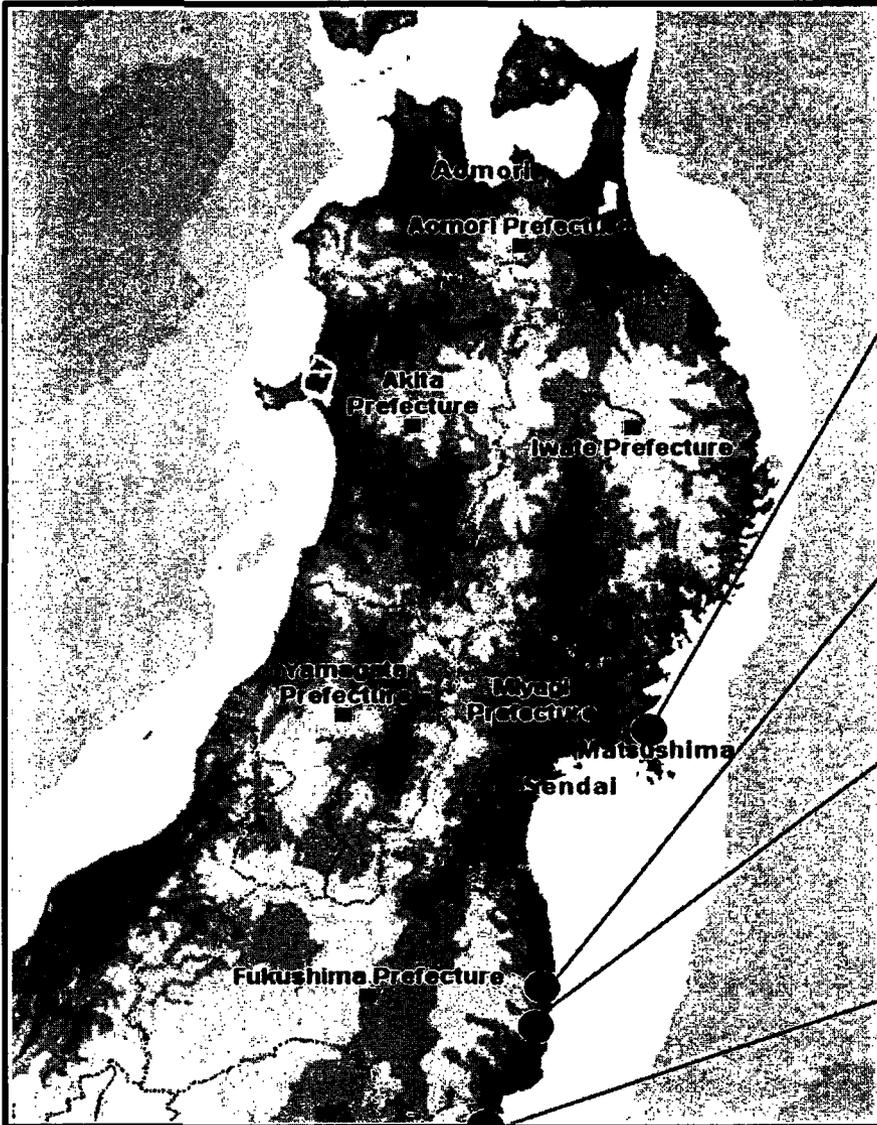
Ministry of Defense



US Navy/US Pacific Command
(Operation Tomodachi)

3. Nuclear Power Stations Nuclear Reactors near Epicenter of the Earthquake

4 Nuclear Power Stations with 14 Units

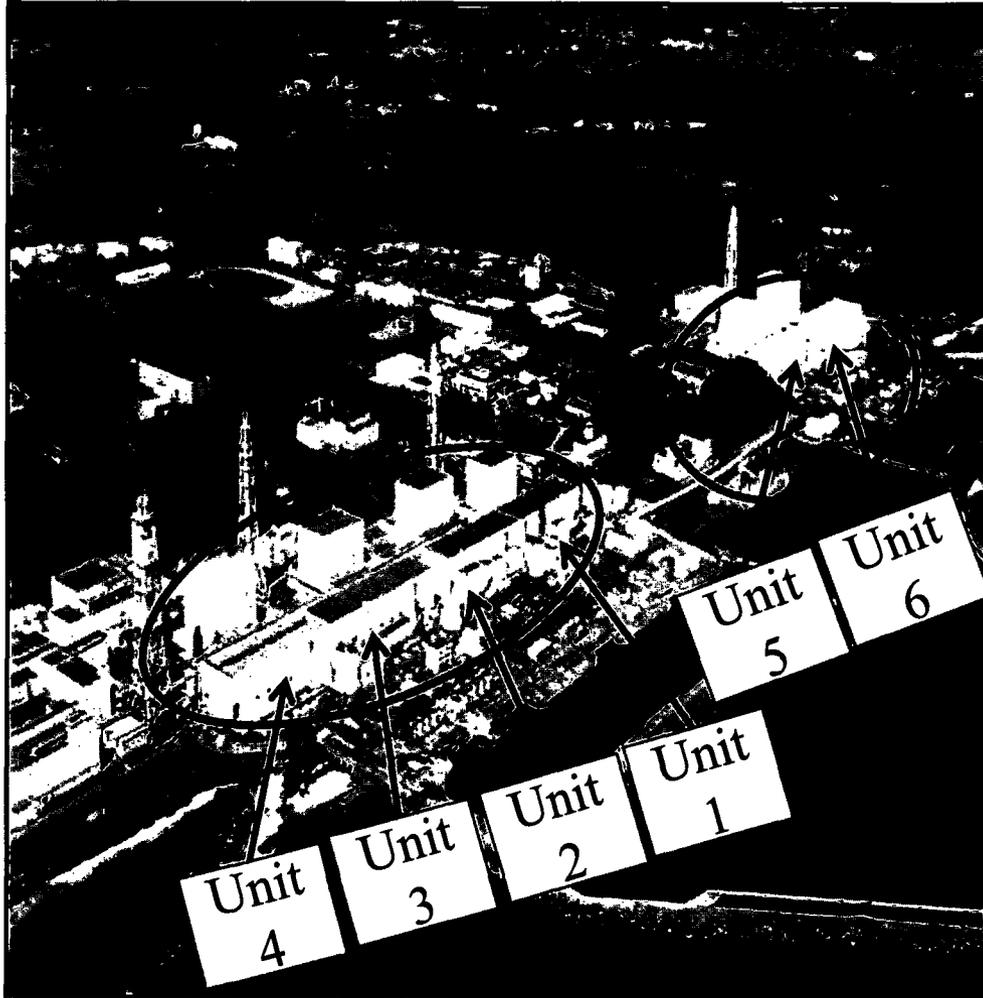


		automatic shut down	cold shut down
Onagawa			
Unit 1	524 MW, 1984-	✓	✓
Unit 2	825 MW, 1995-	✓	✓
Unit 3	825 MW, 2002-	✓	✓
Fukushima Dai-ichi			
Unit 1	460 MW, 1971-	✓	
Unit 2	784 MW, 1974-	✓	
Unit 3	784 MW, 1976-	✓	
Unit 4	784 MW, 1978-	Periodical inspection	✓
Unit 5	784 MW, 1978-	Periodical inspection	✓
Unit 6	1,100 MW, 1979-	Periodical inspection	✓
Fukushima Dai-ni			
Unit 1	1,100 MW, 1982-	✓	✓
Unit 2	1,100 MW, 1984-	✓	✓
Unit 3	1,100 MW, 1985-	✓	✓
Unit 4	1,100 MW, 1987-	✓	✓
Tokai Dai-ni			
Unit 1	1,100 MW, 1978-	✓	✓

3. Nuclear Power Stations

Fukushima Dai-ichi Nuclear Power Station

Before the Earthquake and Tsunamis



TEPCO

After the Earthquake and Tsunamis

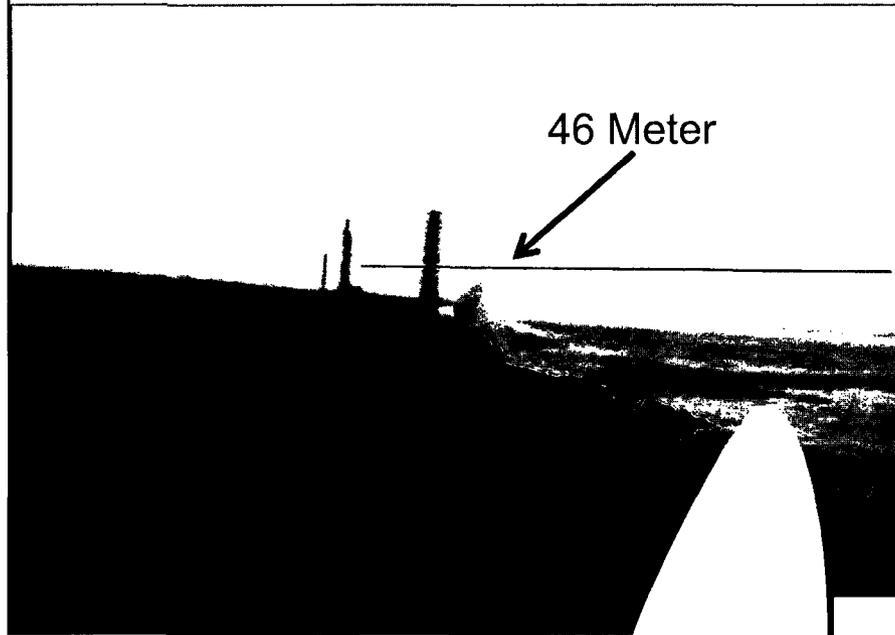


Air Photo Service Inc (Myoko, Niigata Japan)

3. Nuclear Power Stations

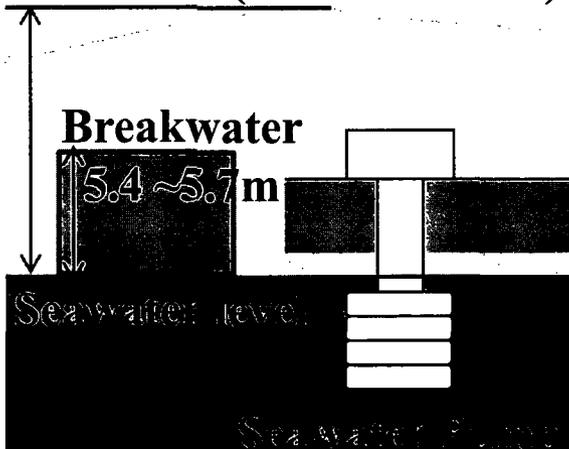
Fukushima Dai-ichi Nuclear Power Station

Huge Tsunami



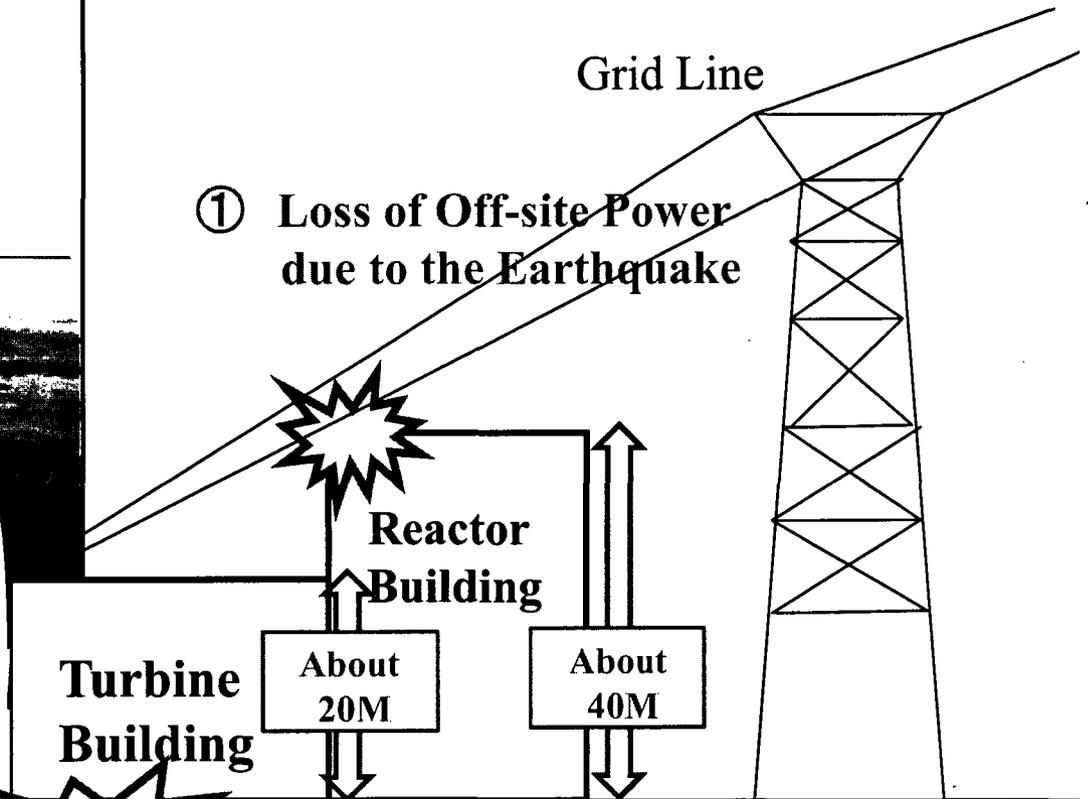
GE Hitachi Nuclear Energy

Tsunami (estimated 14m)



Cause of the Damage

① Loss of Off-site Power due to the Earthquake



Turbine Building

About 20M

About 40M

Reactor Building

Diesel Generator

② Diesel Generator Inoperable due to the Tsunami

All Motion Operated Pumps including ECCS became Inoperable

B. Key Challenges

1. Cool Down the Reactors
2. Contain the Spread of Radioactive Substances
(sea, soil and atmosphere)
3. Rigorous and Intensive Monitoring
4. Ensure the Safety of Food, Drinking Water, On-site Workers, Industrial Products, Ports and Airports

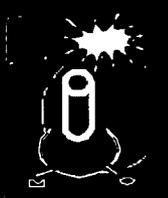
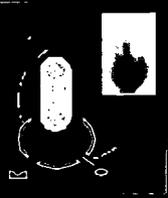
Roadmap towards Settling the Situation of Fukushima Dai-ichi Accident

	Step 1 Around 3 Months	Step 2 Around 3 to 6 Months (after achieving step 1)
Target	Radiation Dose in Steady Decline	Controlling Release of Radioactive Materials (significant reduction of dose level)
Reactors	Stable Cooling (flooding up to top of active fuel)	Achieving Cold Shutdown
Spent Fuel Pools	Stable Cooling	More Stable Cooling (keeping sufficient level of water by remote-control)
Contaminated Water	Prevention of Outflow to the outside of the Site	Decreasing Contaminated Water (decontamination and desalt)
Contaminated Atmosphere/Soil	Prevention of Spread	Covering Up the Entire Reactor Building (as temporary measure)

April 17, TEPCO

1. Cool Down the Reactors

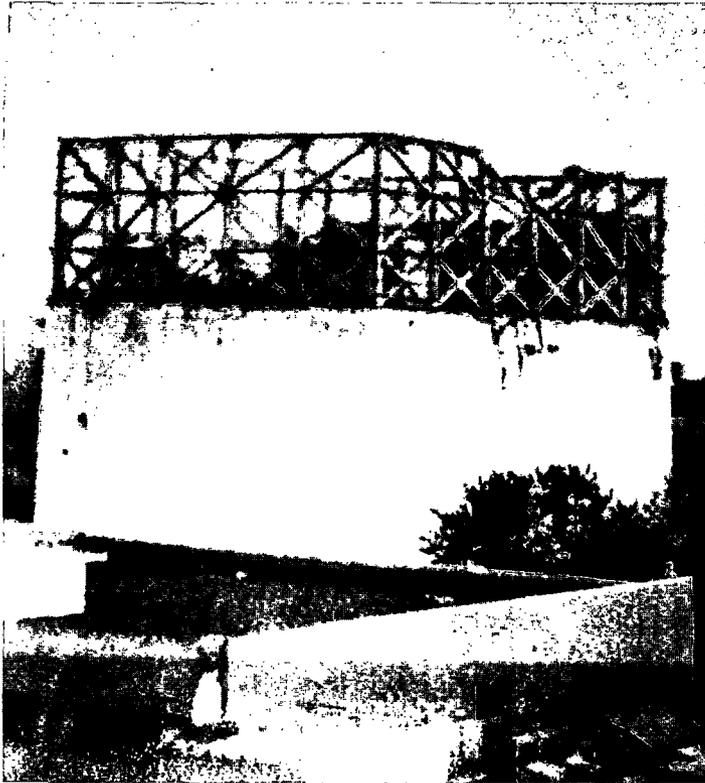
(As of April 18)

		Unit 1	Unit 2	Unit 3	Unit 4
					
Type / MW / Commercial Operation		BWR / 460 / Mar 71-	BWR / 784 / Jul 74-	BWR / 784 / Mar 76-	BWR / 784 / Oct 78-
Status at time of Earthquake		In Service	In Service	In Service	Periodical Inspection Outage
Automatic Shutdown		✓	✓	✓	—
Fresh Water Injection		✓	✓	✓	—
R P V	Water Level [mm]	-1,650 (A)	-1,500 (A)	-1,800 (A)	—
	(distance from the top of fuel)	-1,650 (B)	-2,100 (B)	-2,250 (B)	—
	Reactor Pressure [Mpa g]	0.428 (A)	-0.023 (A)	-0.034 (A)	—
		1.035 (B)	-0.032 (D)	-0.081(C)	—
	Temperature				—
	— Feedwater Nozzle	170.2°C	140.8°C	101.5°C	—
	— Bottom Head of RPV	115.2°C	N/A	112.7°C	—
S F P	Fresh Water Injection	✓	✓	✓	✓
	Temperature	Not available	71°C	Not available	Not available
Building		Damage	Slight Damage	Damage	Damage
AC Power		✓	✓	✓	✓
(Lighting of Central Operation Room*)		✓	✓	✓	✓

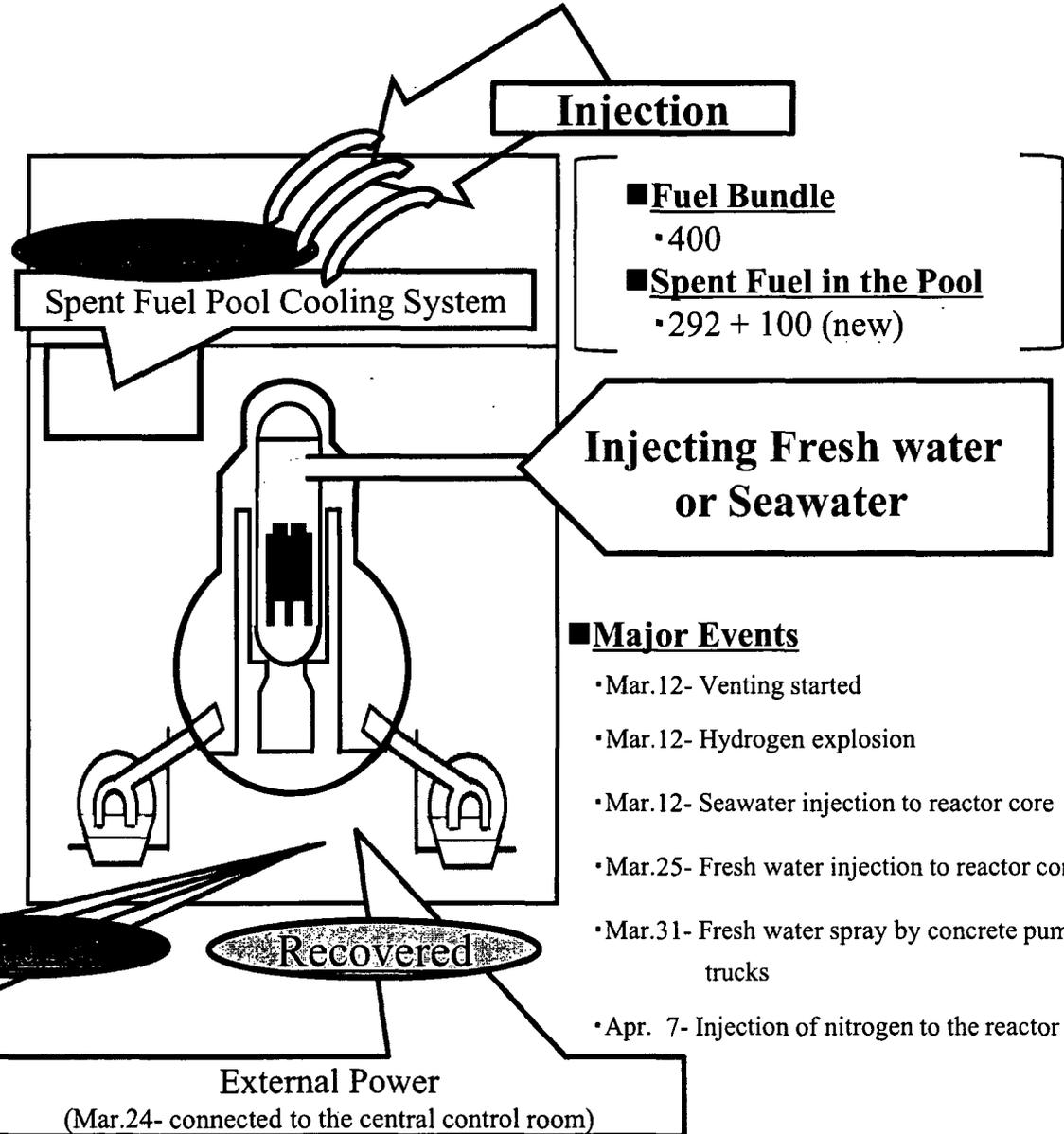
* Facilities are under-checking.

1. Cool Down the Reactors (Unit 1)

(As of April 17, 2011)



TEPCO

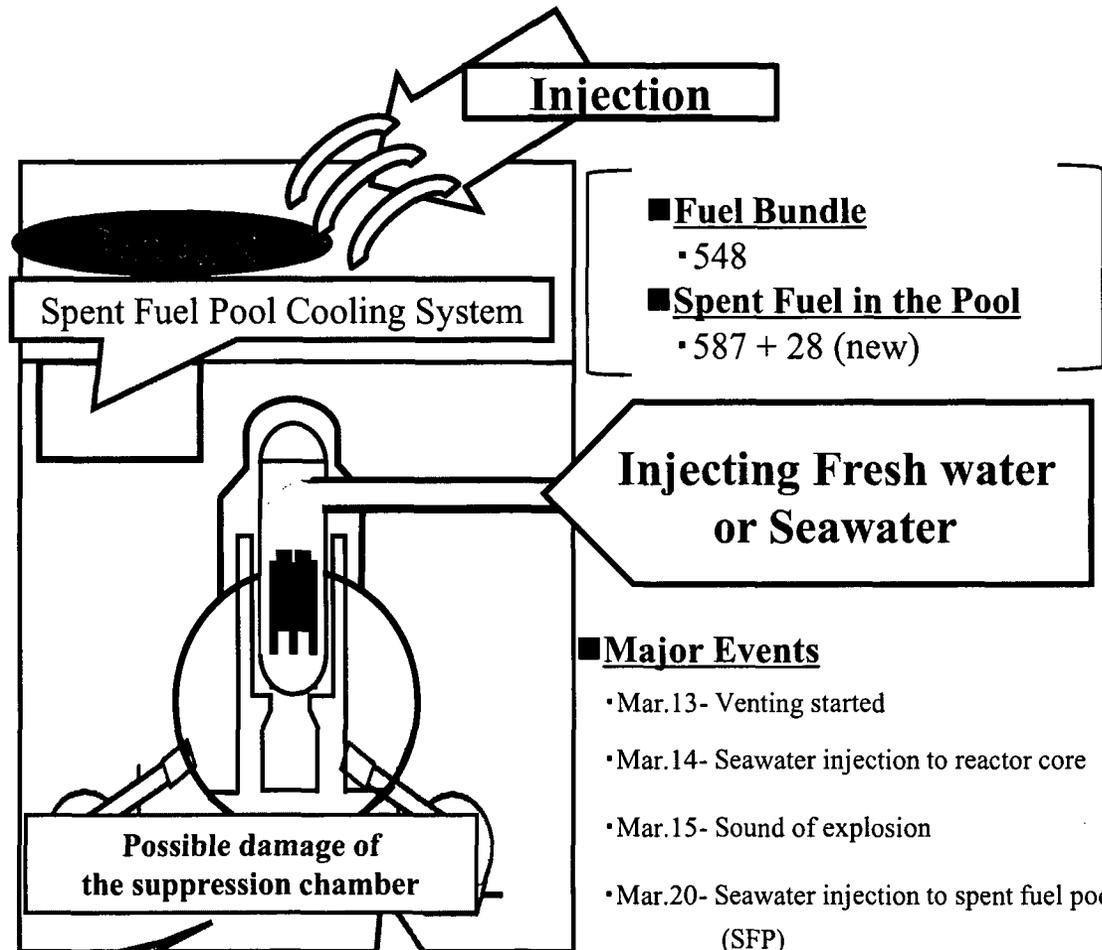


1. Cool Down the Reactors (Unit 2)

(As of April 17, 2011)



Ministry of Defense



■ **Fuel Bundle**

• 548

■ **Spent Fuel in the Pool**

• 587 + 28 (new)

Injecting Fresh water or Seawater

■ **Major Events**

- Mar.13- Venting started
- Mar.14- Seawater injection to reactor core
- Mar.15- Sound of explosion
- Mar.20- Seawater injection to spent fuel pool (SFP)
- Mar.26- Fresh water injection to reactor core
- Mar. 29- Fresh water injection to SFP

Possible damage of the suppression chamber

Recovered

Emergency Diesel Generator

Residual Heat Removal System

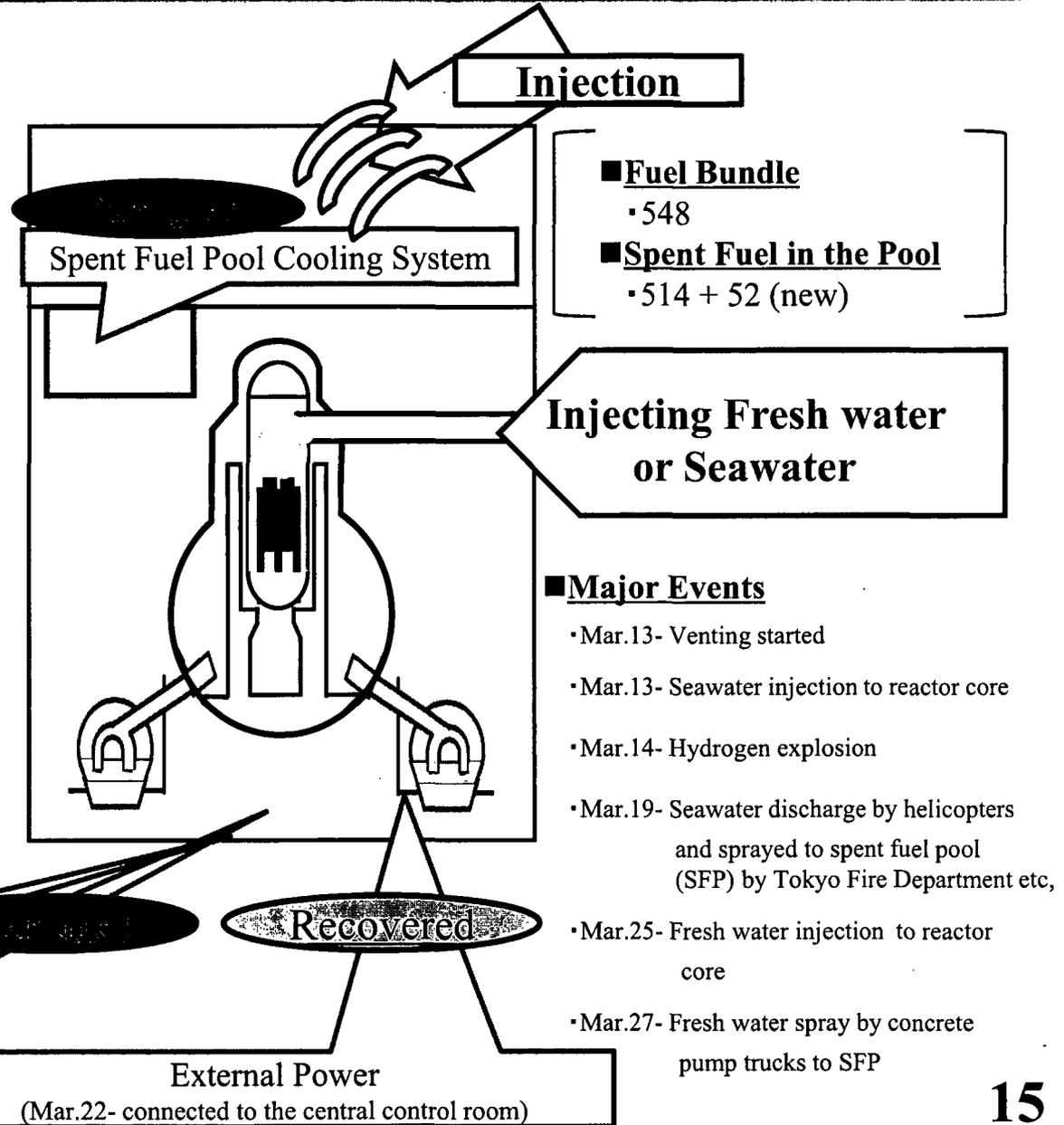
External Power
(Mar.26- connected to the central control room)

1. Cool Down the Reactors (Unit 3)

(As of April 17, 2011)

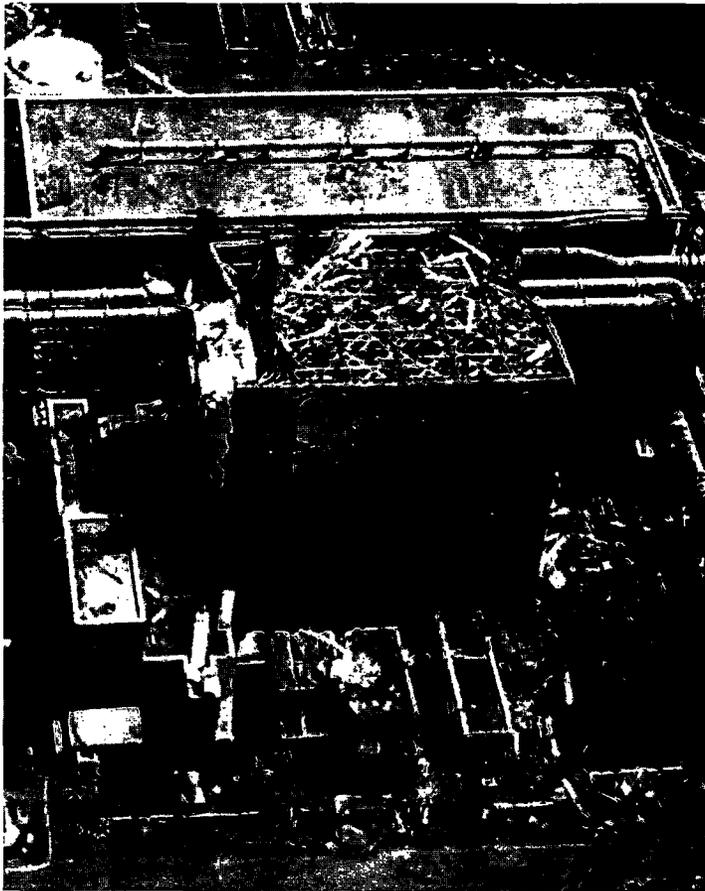


Air Photo Service Inc (Myoko, Niigata Japan)

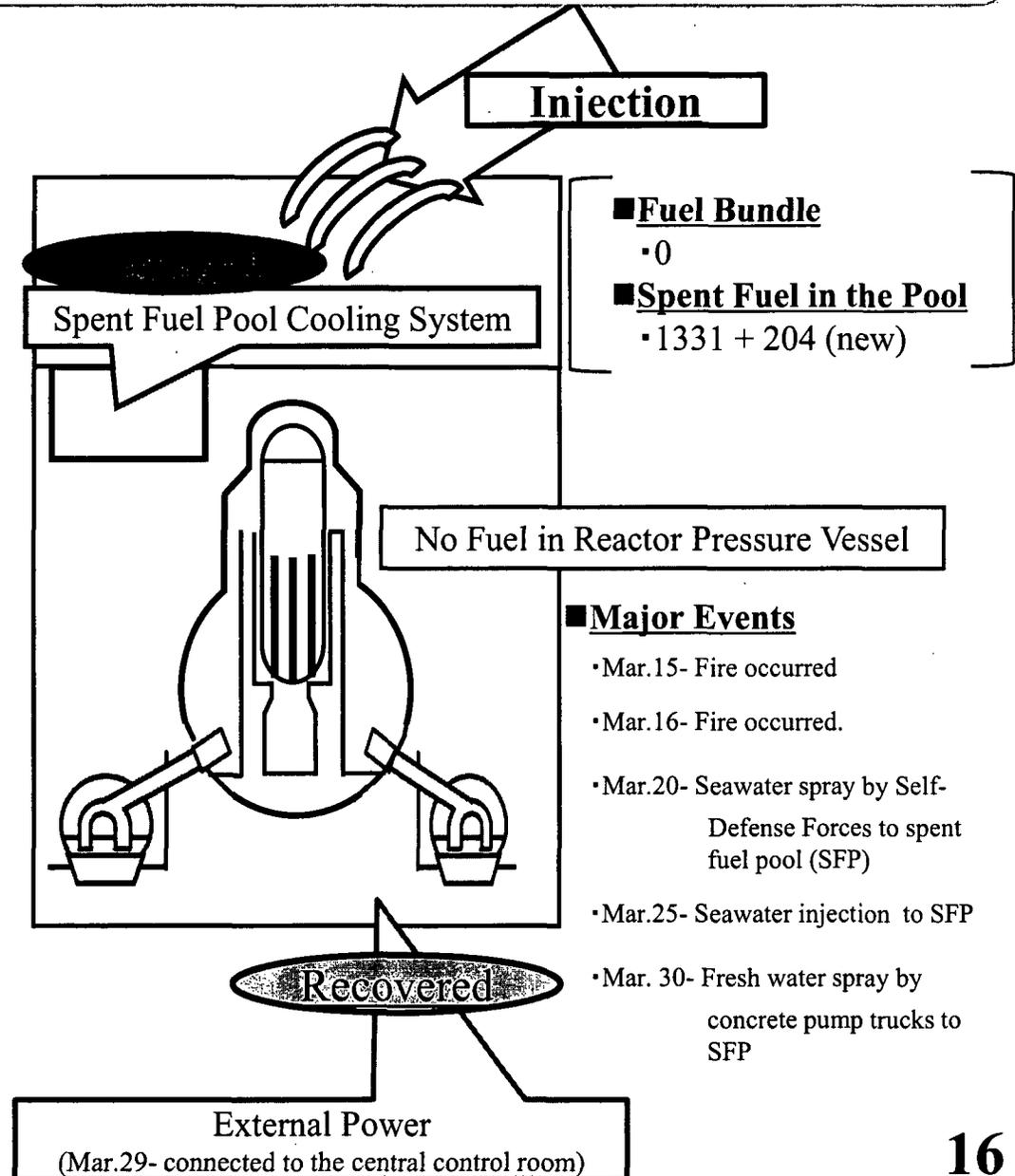


1. Cool Down the Reactors (Unit 4)

(As of April 17, 2011)



Air Photo Service Inc (Myoko, Niigata Japan)



1. Cool Down the Reactors (Unit 5&6)

(As of April 17, 2011)

■ **Fuel Bundle**

• Unit 5 : 548

■ **Spent Fuel in the Pool**

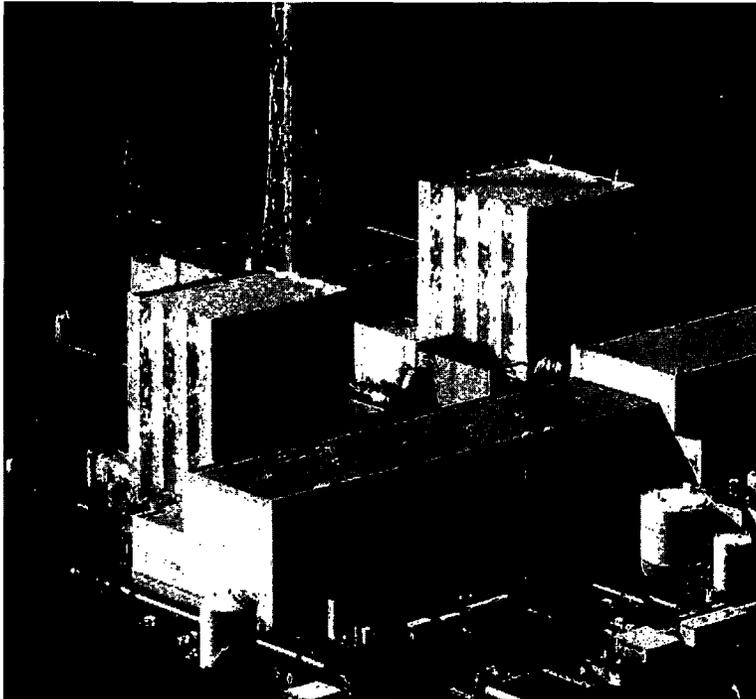
• Unit 5 : 946 + 48 (new)

■ **Fuel Bundle**

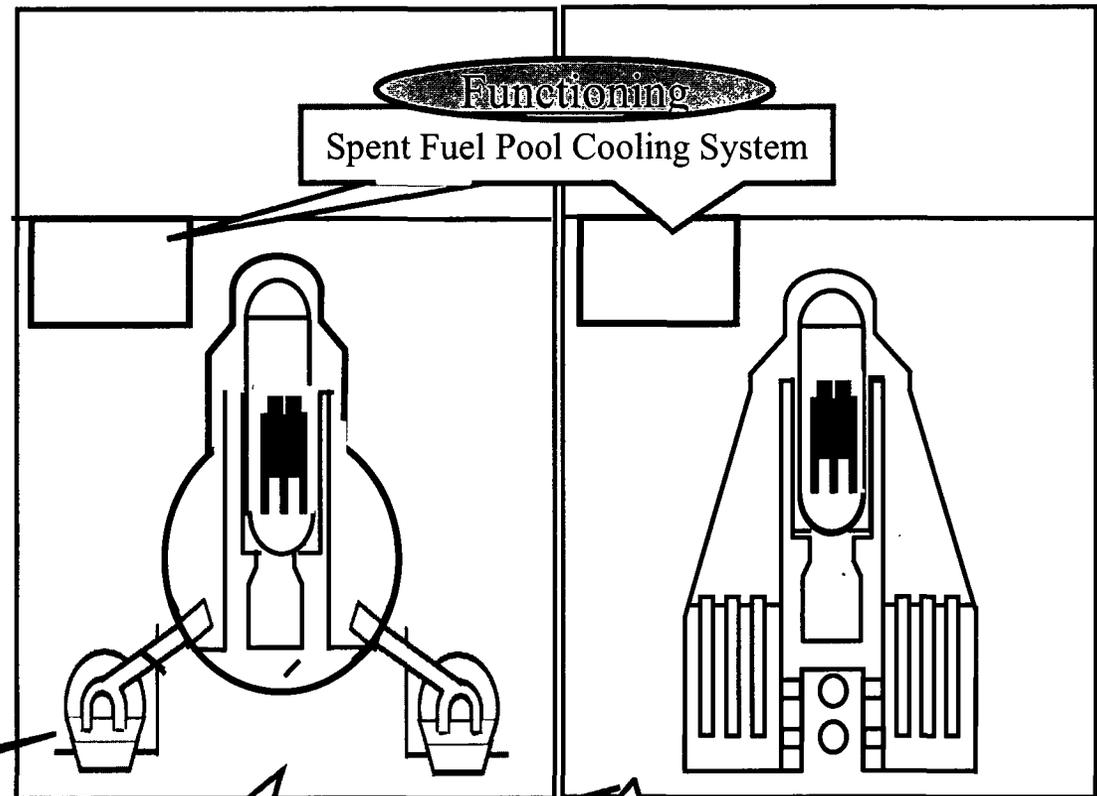
• Unit 6 : 764

■ **Spent Fuel in the Pool**

• Unit 6 : 876 + 64 (new)



KYODO NEWS



Functioning

External Power [Unit 5]

Emergency Diesel Generator

Residual Heat Removal System

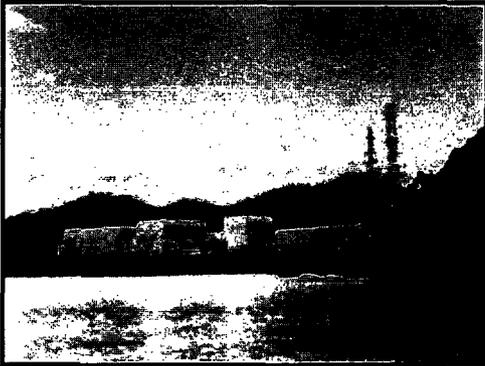
Recovered

External Power [Unit 6]

(Mar.22- connected to the central control room)

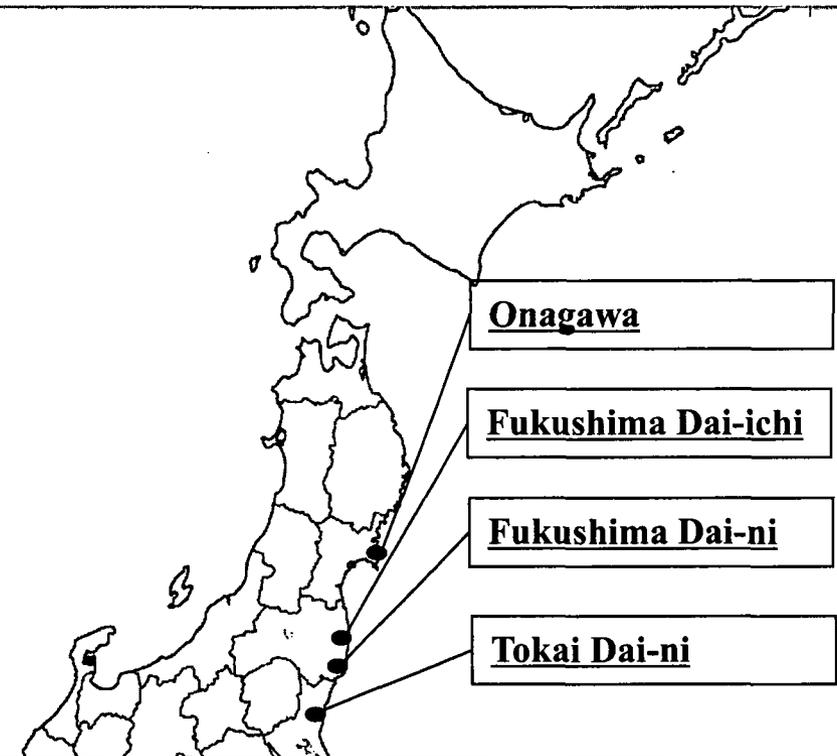
Other Nuclear Power Stations in the Tohoku Area

Onagawa (3 Units)



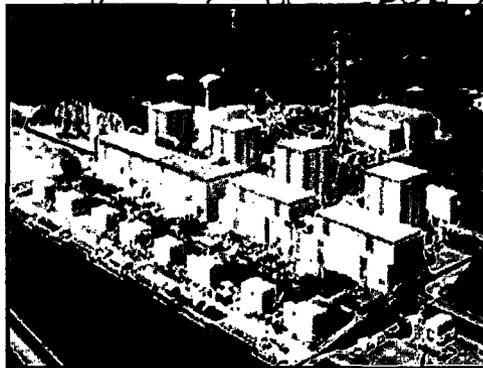
Tohoku Electric Power Co., Inc

All units (Units 1-3) were immediately shut down automatically, then safely went into cold shutdown.



Fukushima Dai-ni (4 Units)

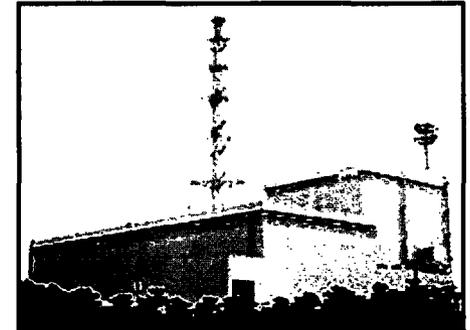
All units (Units 1-4) were immediately shut down automatically, then safely went to cold shutdown.



TEPCO

Tokai Dai-ni (1 Unit)

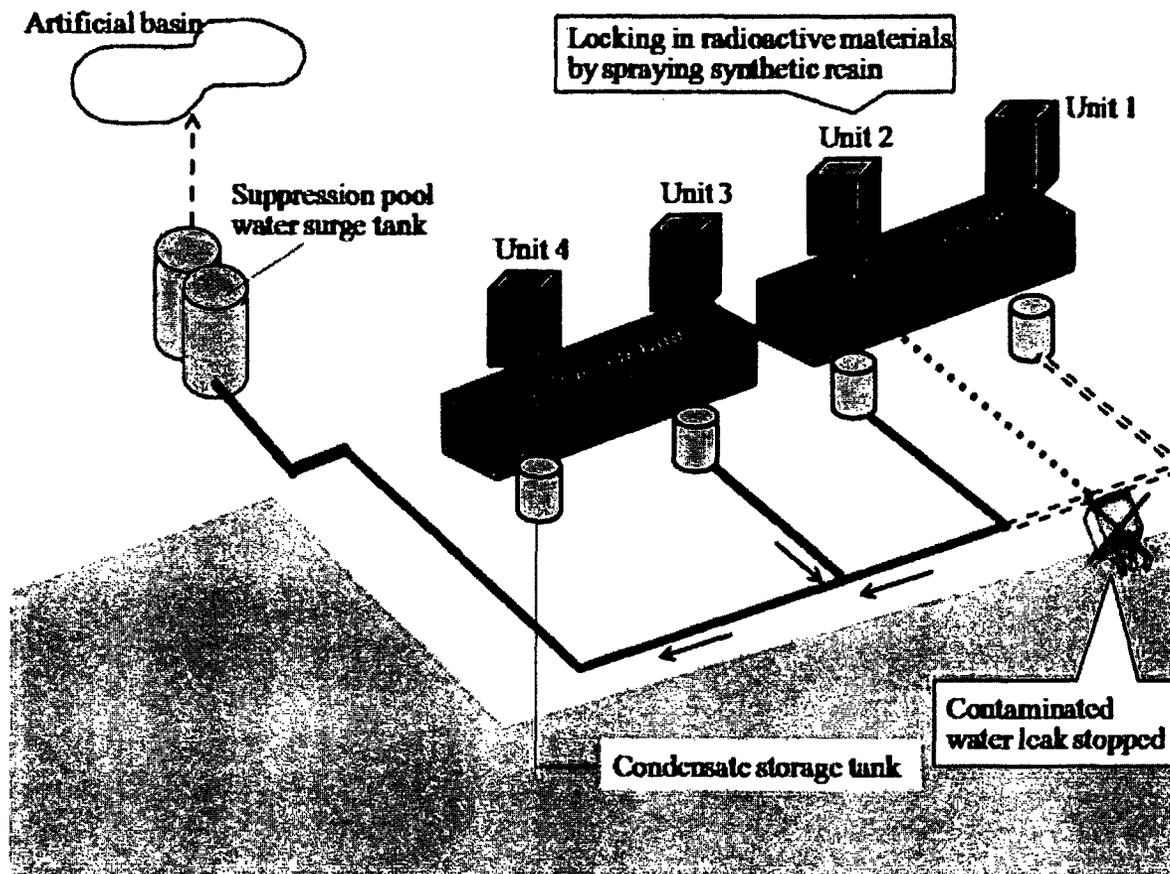
The unit was immediately shut down automatically, then safely went to cold shutdown.



The Japan Atomic Power Company

2. Contain the Spread of Radioactive Substances (sea, soil and atmosphere)

The Japanese Government and TEPCO are making the utmost efforts to prevent the dispersion of flow-out radioactive contaminated water.



■ Major Events

- Mar. 27
Stagnant water on the basement floor of the turbine of Unit 2 and in the trenches found to be highly contaminated.
- Mar. 29
Stagnant water in the trenches and the turbine building transferred to the storage tank, then to the surge tank.
- Apr. 1
Highly contaminated water discovered leaking into the sea.
- Apr. 6
Leak of contaminated water into the sea was stopped.
- Apr. 19
Transfer of stagnant water in the trench of Unit 2 was started

2. Contain the Spread of Radioactive Substances (sea, soil and atmosphere)

Experts are making the utmost efforts to prevent dispersing radioactive substances contained in dust, debris and vapor.

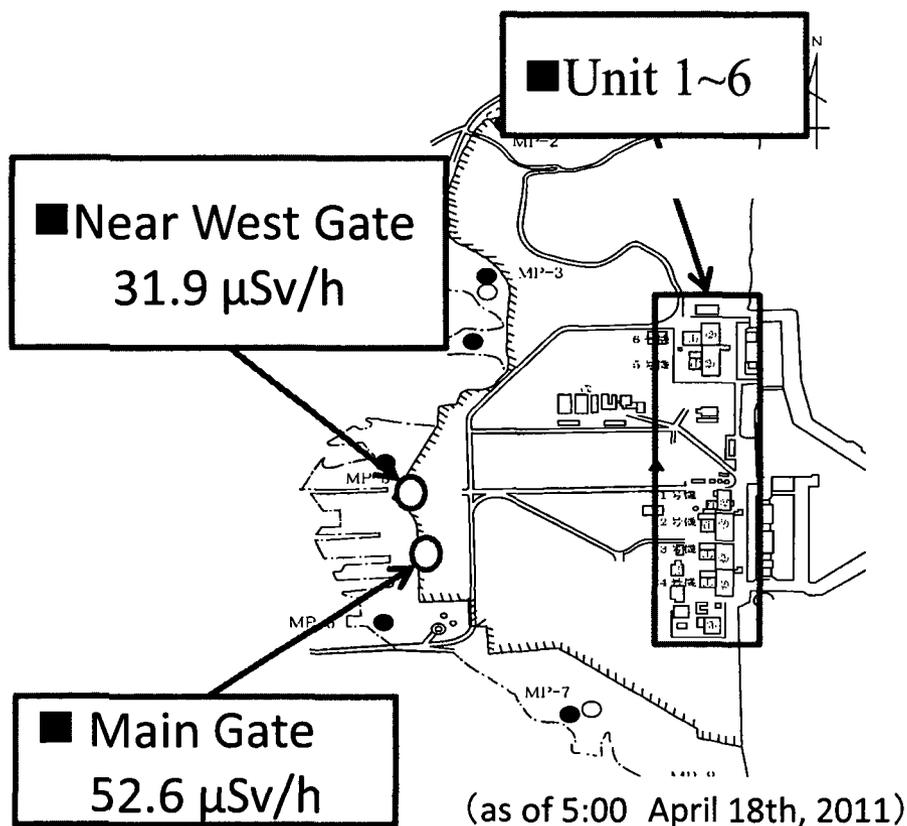
**Spraying synthetic materials on the surface of the ground
and debris to prevent radioactive substances dispersion**



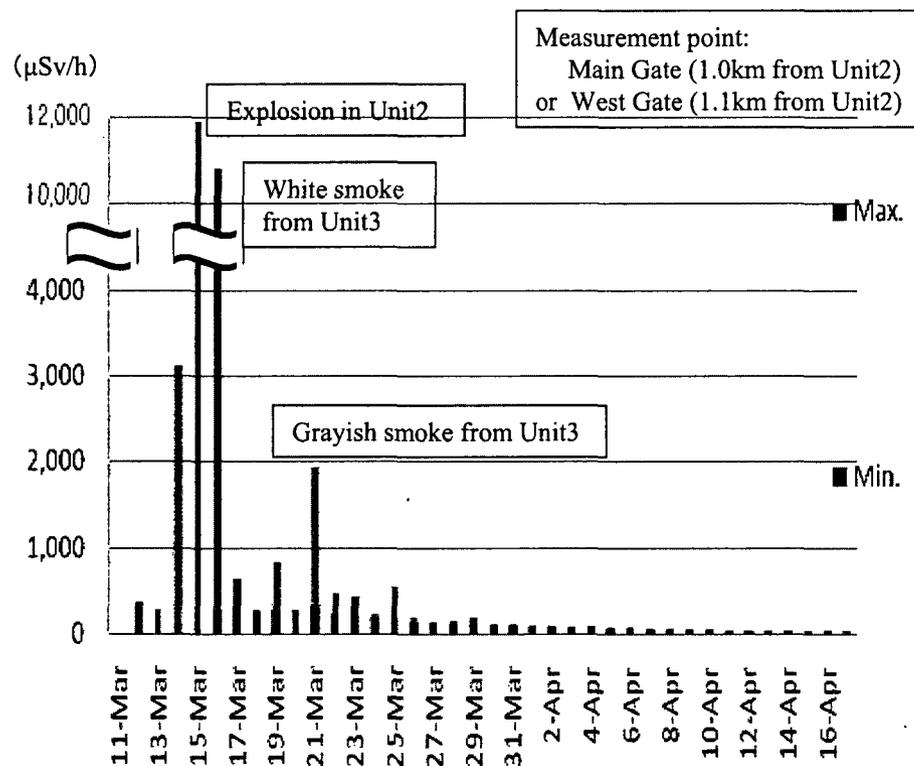
3. Rigorous and Intensive Monitoring

TEPCO monitors radioactivity levels every ten minutes and releases the results immediately. Radioactivity levels rose on March 15th, but have since fallen and remain low.

Monitoring posts and the readings at the Fukushima Dai-ichi NPS

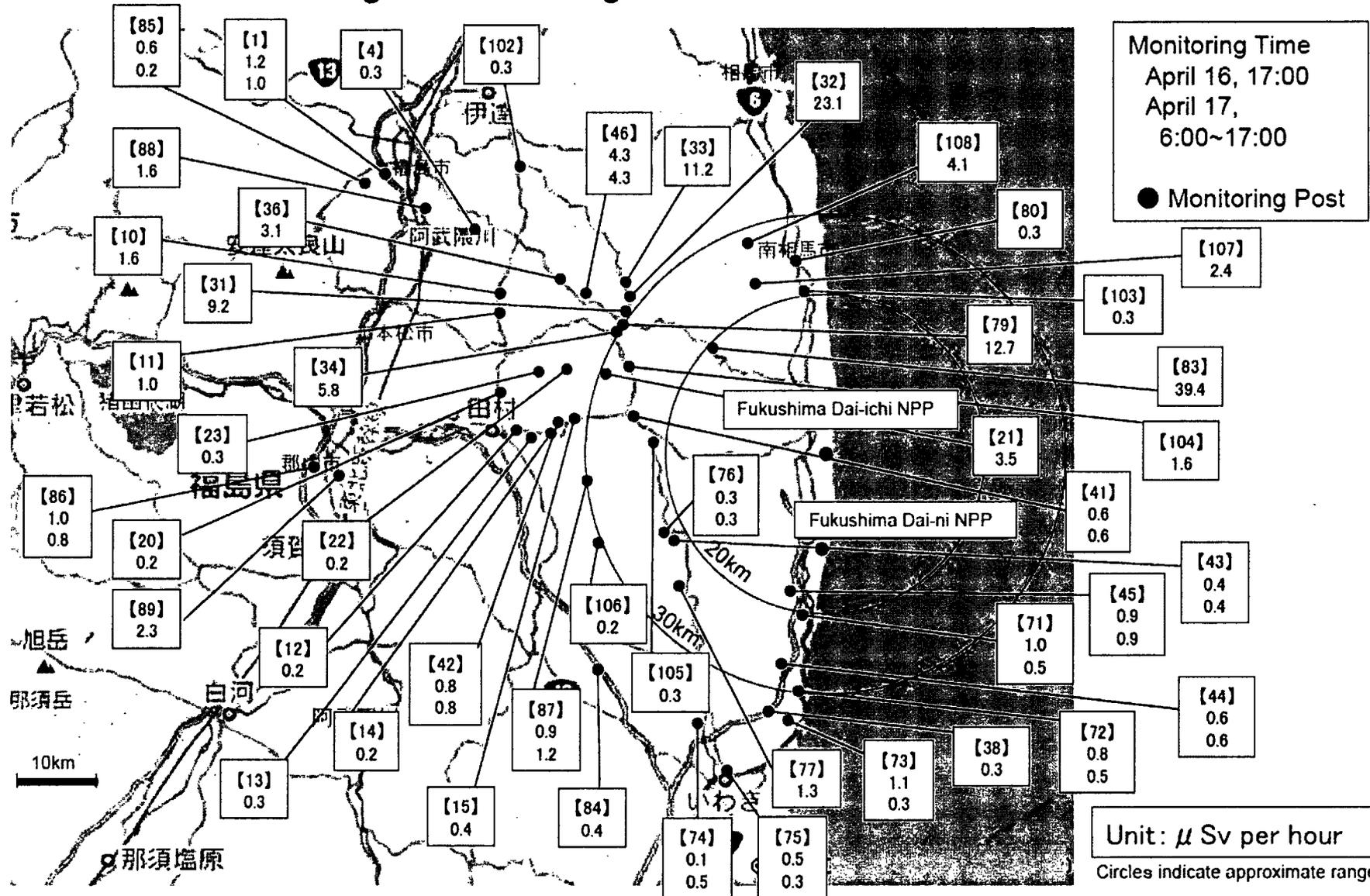


Environmental Radioactivity Level at the Fukushima Dai-ichi NPS

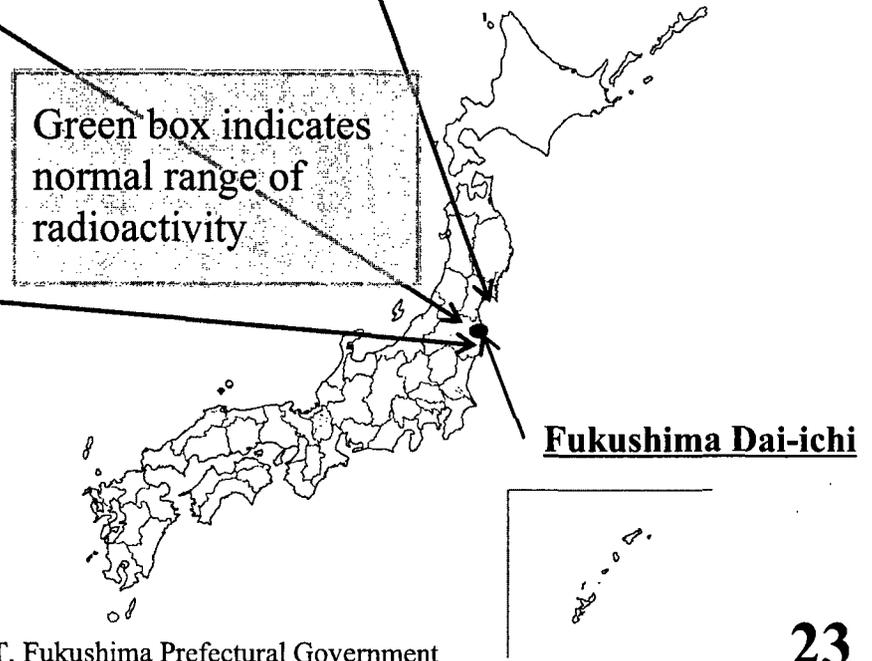
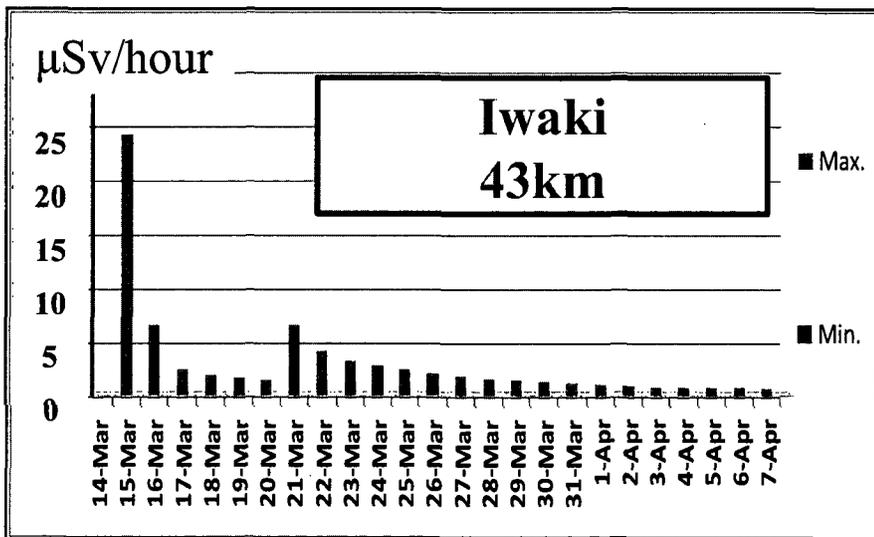
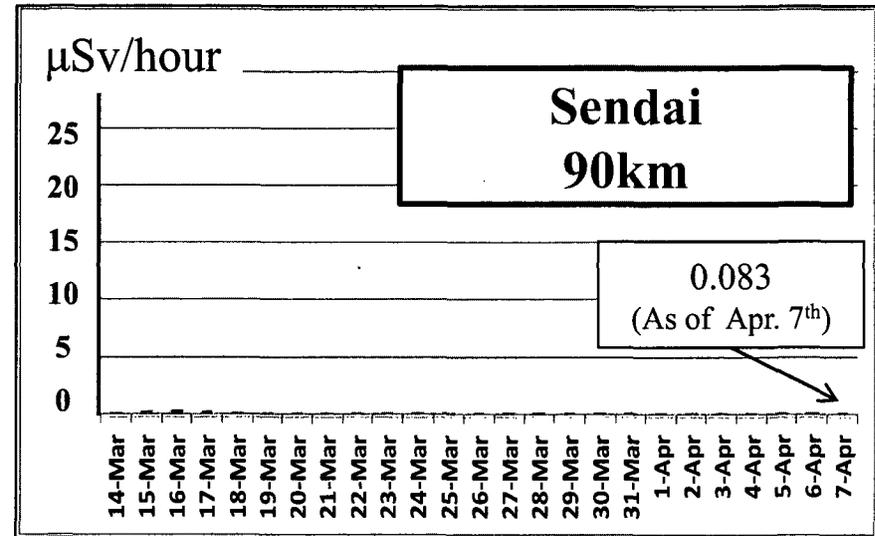
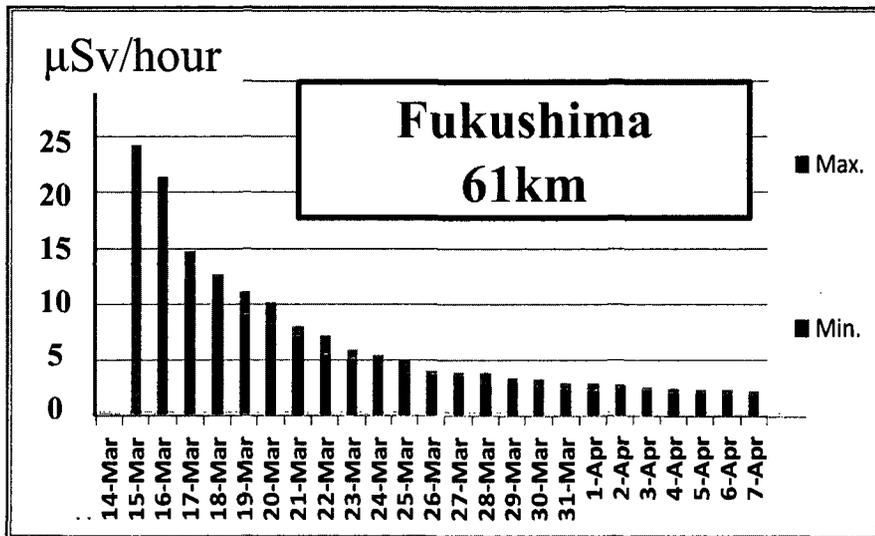


Readings at Monitoring Posts out of Fukushima Dai-ichi NPS

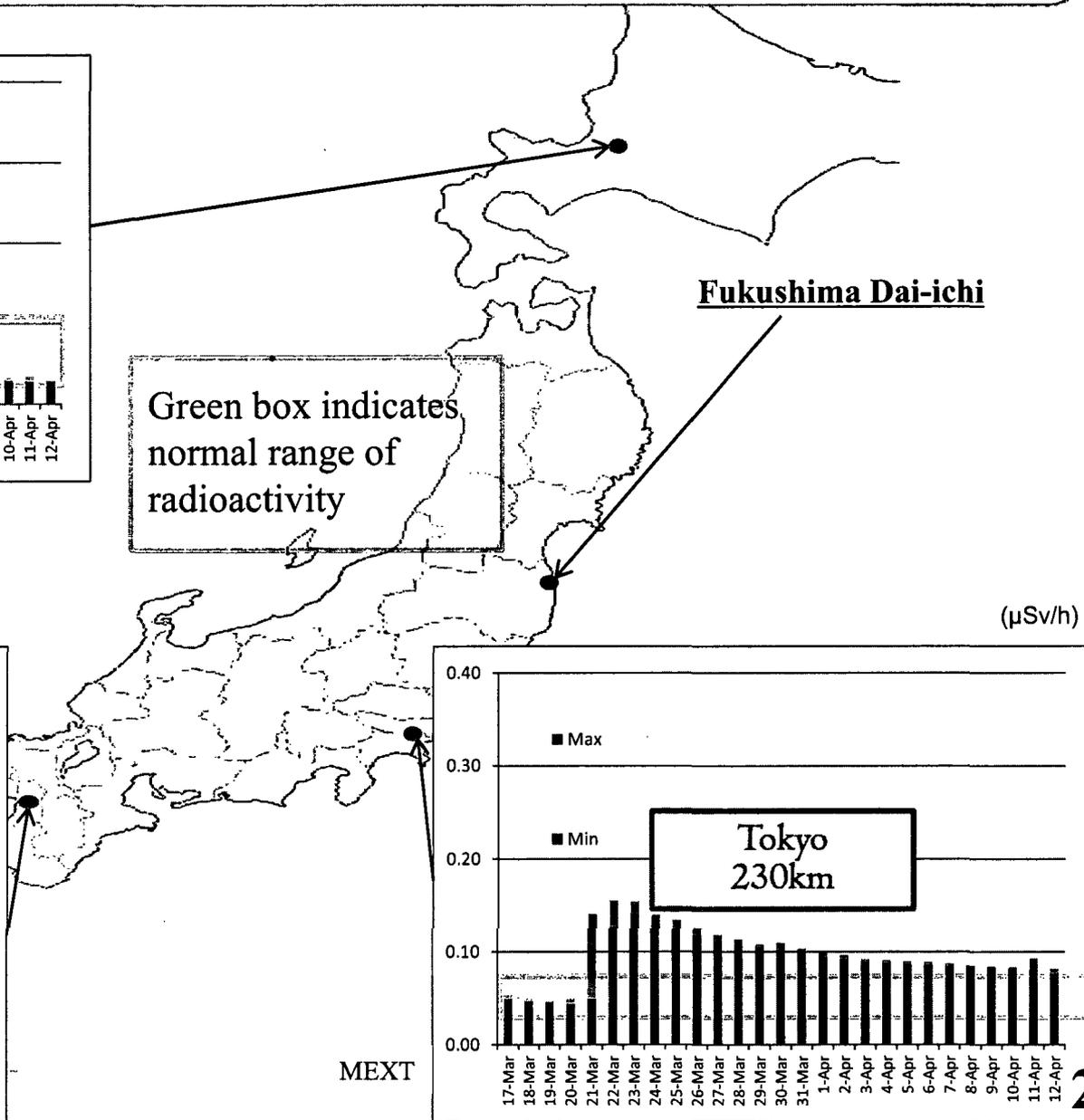
Readings at Monitoring Post out of Fukushima Dai-ichi NPP



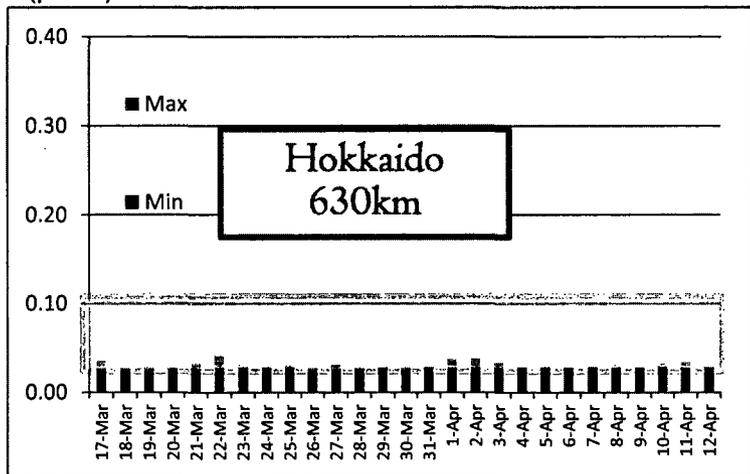
Atmospheric Readings within 100km



Atmospheric Readings in Tokyo, Osaka and Sapporo

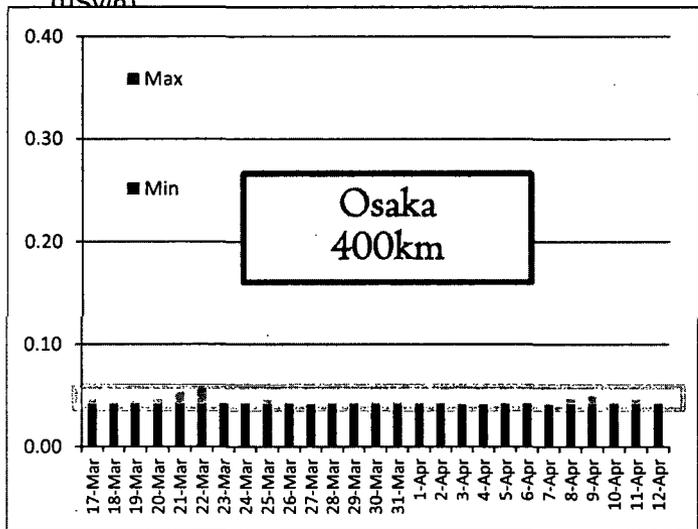


($\mu\text{Sv/h}$)



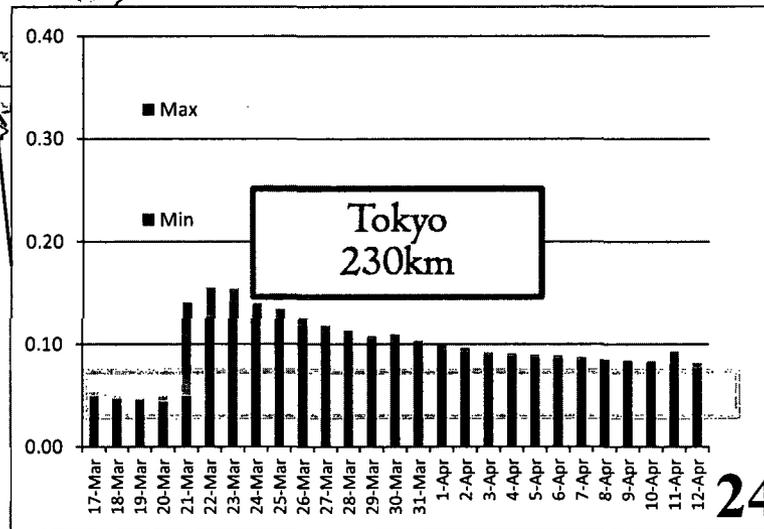
Green box indicates normal range of radioactivity

($\mu\text{Sv/h}$)



MEXT

($\mu\text{Sv/h}$)



4. Ensure the Safety of Food, Drinking Water, On-site Workers, Industrial Products, Ports and Airports

Ensure the Safety of Food

Japan inspects radioactivity in food every day, and restricts distribution of food that fails to meet provisional regulation values taking into consideration the spread of contamination.

Instructions (as of 20 April 2011)

... Not to Distribute

* Fukushima Prefecture

- Raw milk
- Non-head type leafy vegetables (e.g. spinach)
- Head type leafy vegetables (e.g. cabbage)
- Flowerhead brassicas (e.g. broccoli, cauliflower)
- Turnip
- Log grown shiitake (grown outdoor)
- Juvenile (baby) fish of Japanese sand lance

* Ibaraki Prefecture

- Spinach

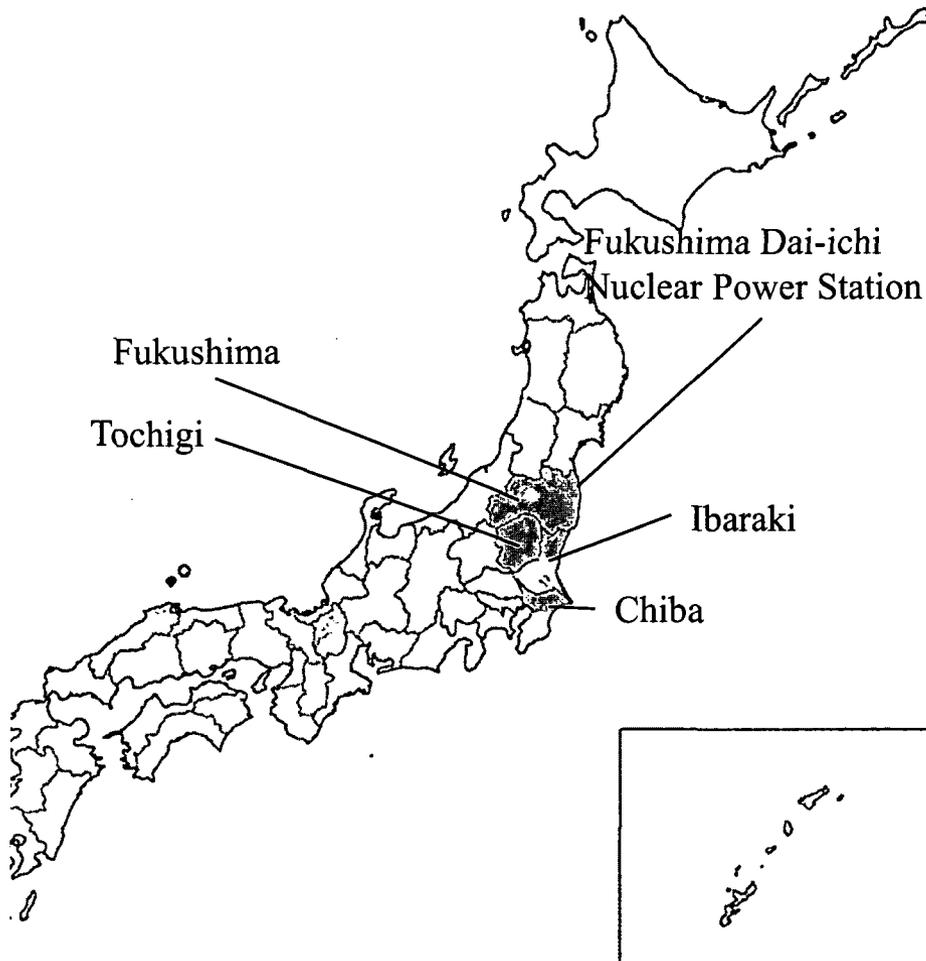
* Tochigi Prefecture

- Spinach

* Chiba Prefecture

- Spinach etc.

Please refer to the next slide for the details of the Instructions.



Source: Ministry of Health, Labour and Welfare

The instructions associated with food by Director-General of the Nuclear Emergency Response Headquarters

as of 20 April 2011

			Restriction of distribution							
			Fukushima		Ibaraki		Tochigi	Gunma	Chiba	
			Whole area	Individual areas	Whole area	Individual areas	Whole area	Whole area	Whole area	Individual areas
raw milk			<i>3/21~ (excluding areas listed on the right cells)</i>	3/21~4/8 Kitakata-shi, Bandai-machi, Inawashiro-machi, Mishima-machi, Aizumisato-machi, Shimogo-machi, Minamiaizu-machi	3/23~ 4/10	-	-	-	-	
				3/21~4/16 Fukushima-shi, Nihonmatsu-shi, Date-shi, Motomiya-shi, Kunimi-machi, Otama-mura, Koriyama-shi, Sukagawa-shi, Tamura-shi (excluding Miyakoji area), Miharu-machi, Ono-machi, Kagamiishi-machi, Ishikawa-machi, Asakawa-machi, Hirata-mura, Furudono-machi, Shirakawa-shi, Yabuki-machi, Izumizaki-mura, Nakajima-mura, Saigo-mura, Samekawa-mura, Hanawa-machi, Yamatsuri-machi, Iwaki-shi						
Vegetable	non-head type leafy vegetables, e.g. spinach, komatsuna	spinach	<i>3/21~</i>	3/21~4/17 (excluding areas listed on the	<i>3/21~ Kitaibaraki-shi, Takehagi-shi</i>	<i>3/21~</i>	3/21~4/8	-	<i>4/4~ Asahi-shi, Katori-shi, Tako-machi</i>	
		kakina	<i>3/21~</i>	3/21~4/17	-	3/21~4/14	3/21~4/8	-	-	
		garland chrysanthemum (shungiku)	<i>3/23~</i>	-	-	-	-	-	<i>4/4~ Asahi-shi</i>	
		qing-geng-cai	<i>3/23~</i>	-	-	-	-	-	<i>4/4~ Asahi-shi</i>	
		sanchu asian lettuce	<i>3/23~</i>	-	-	-	-	-	<i>4/4~ Asahi-shi</i>	
		all the other	<i>3/23~</i>	-	-	-	-	-	-	
	head type leafy vegetables, e.g. cabbage	<i>3/23~</i>	-	-	-	-	-	-		
	flowerhead brassicas, e.g. broccoli, cauliflower	<i>3/23~</i>	-	-	-	-	-	-		
	turnip	<i>3/23~</i>	-	-	-	-	-	-		
	parsley	-	3/23~4/17	-	-	-	-	<i>4/4~ Asahi-shi</i>		
	celery	-	-	-	-	-	-	<i>4/4~ Asahi-shi</i>		
	log-grown shiitake (grown outdoor)	-	<i>4/13~ Shinchi-machi, Date-shi, Iitate-mura, Soma-shi, Minamisoma-shi, Namie-machi, Futaba-machi, Okuma-machi, Tomioka-machi, Naraha-machi, Hirono-machi, Kawamata-machi, Katsurao-mura, Tamura-shi, Kawauchi-mura, Iwaki-shi</i>	-	-	-	-	-		
		<i>4/18~ Fukushima-shi</i>								
fishery product	sand lance (juvenile)	<i>4/20~</i>	-	-	-	-	-			

* Instructions still imposed are expressed in *italic type*.

Test Result of Radionuclide in Fresh Produce

March 16-31

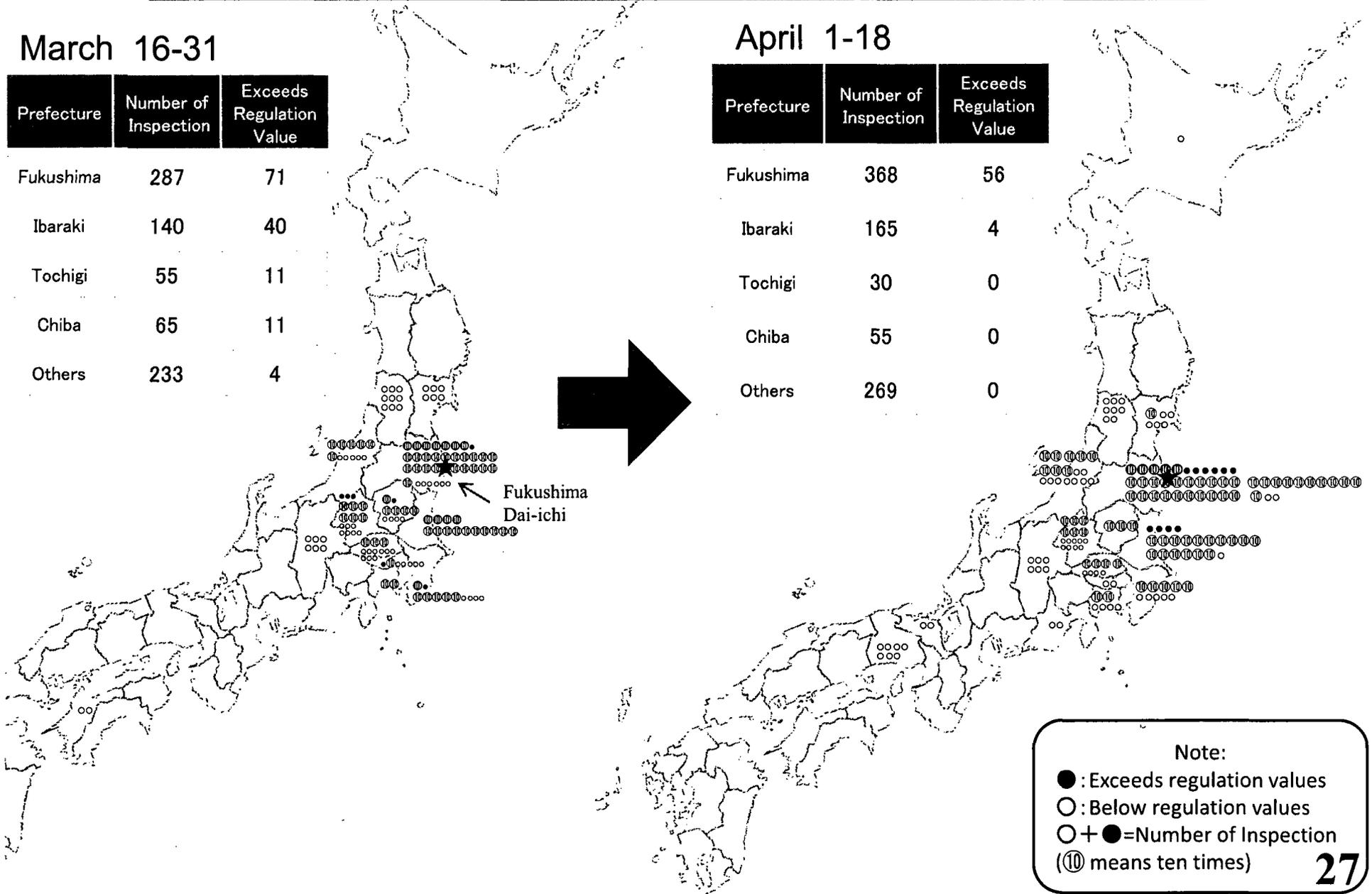
Prefecture	Number of Inspection	Exceeds Regulation Value
------------	----------------------	--------------------------

Fukushima	287	71
Ibaraki	140	40
Tochigi	55	11
Chiba	65	11
Others	233	4

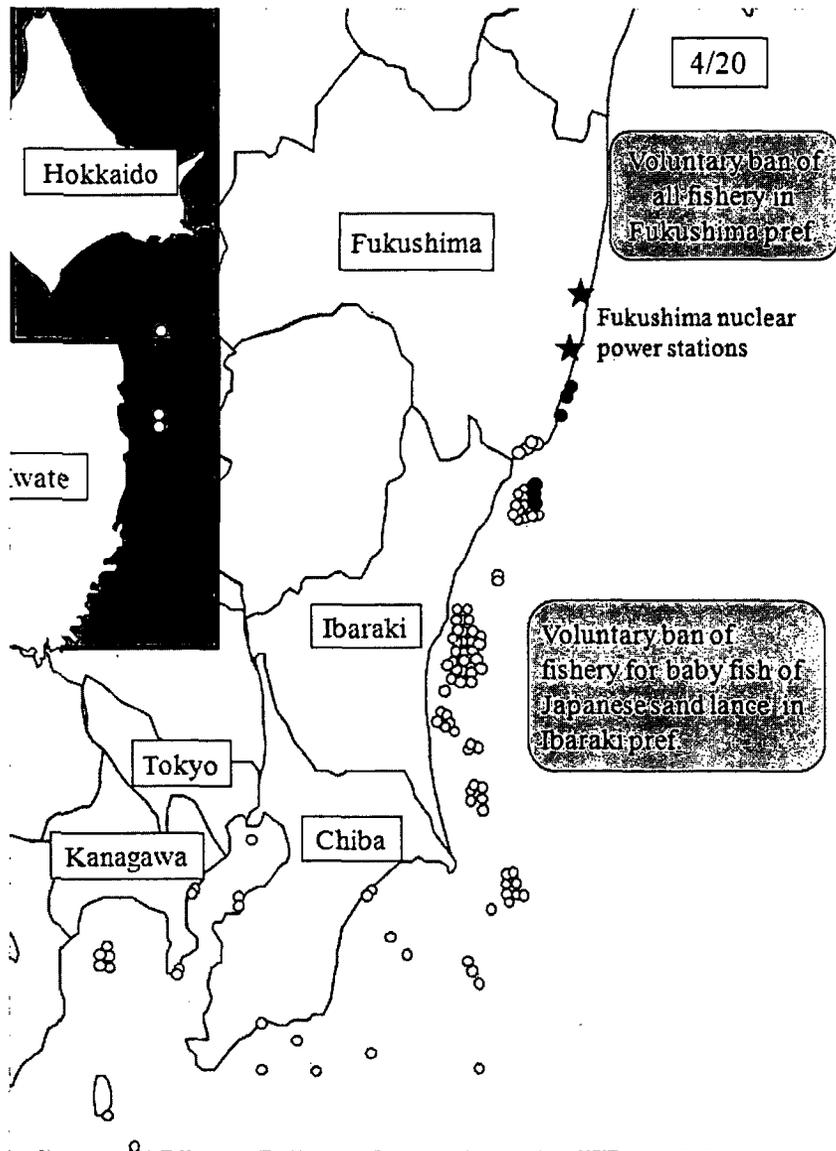
April 1-18

Prefecture	Number of Inspection	Exceeds Regulation Value
------------	----------------------	--------------------------

Fukushima	368	56
Ibaraki	165	4
Tochigi	30	0
Chiba	55	0
Others	269	0



Safety of Marine Food



- Over provisional regulation values: 6 samples
- Below provisional regulation values: 119 samples

All 6 samples over provisional regulation values: Juvenile (baby) fish of “Japanese sand lance”, which inhabits in very surface water influenced by radionuclides

Fisheries of this fish species :
not conducted in Fukushima prefecture and Ibaraki prefecture

All fisheries:
not conducted in Fukushima prefecture

Safety of Drinking Water

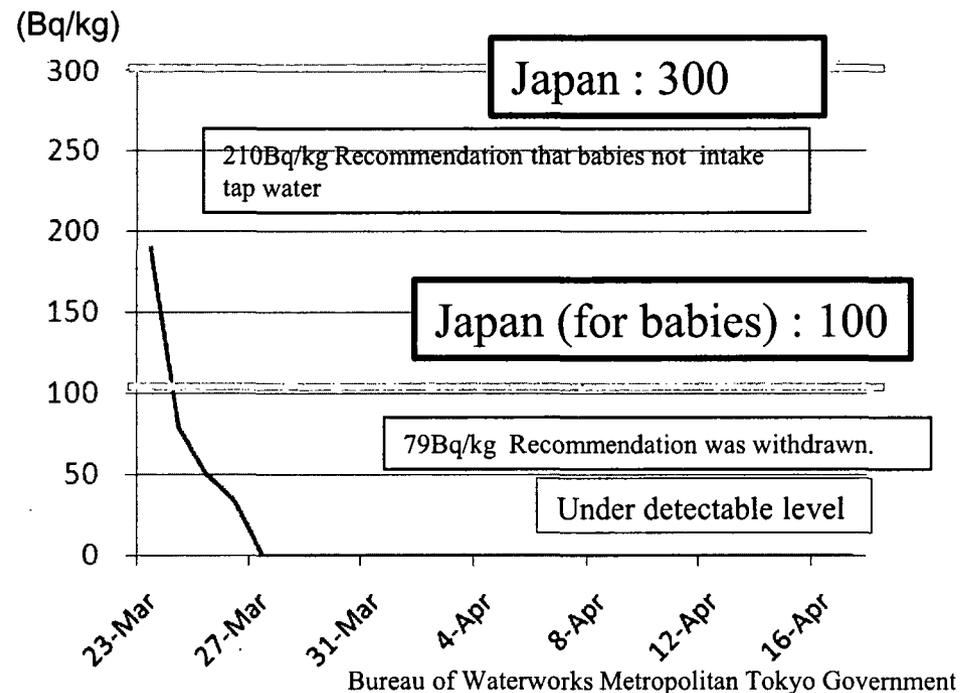
The Japanese Government has been implementing necessary measures based on its stringent criteria for radionuclides in drinking water, and monitoring radionuclide levels every day.

Guidance Levels for Radionuclides in Drinking Water

(Bq/kg)	Japan	EU
radioactive iodine(I131)	300	500
radioactive iodine(I131) (for babies)	100	
radioactive cesium	200	1,000

Ministry of Health, Labour and Welfare, EURATOM

Radioactive Iodine(I131) in Drinking-Water in Tokyo (Kanamachi filter plant)



*On March 23, the Japanese Government recommended that the residents in Tokyo area refrain from having their babies intake tap water, but it withdraw the recommendation in two days.

Safety of On-site Workers

The Japanese Government closely supervises on-site workers' health conditions, limiting the level of their maximum exposure to radiation to 250mSv.

No workers in Fukushima NPS have been exposed to 250mSv or more.

Emergency Dose Limit

mSv	JAPAN
emergency dose limit	100 ↓ 250 (limit raised for Fukushima emergency workers)

Ministry of Health, Labour and Welfare, Nuclear and Industrial Safety Agency, ICRP

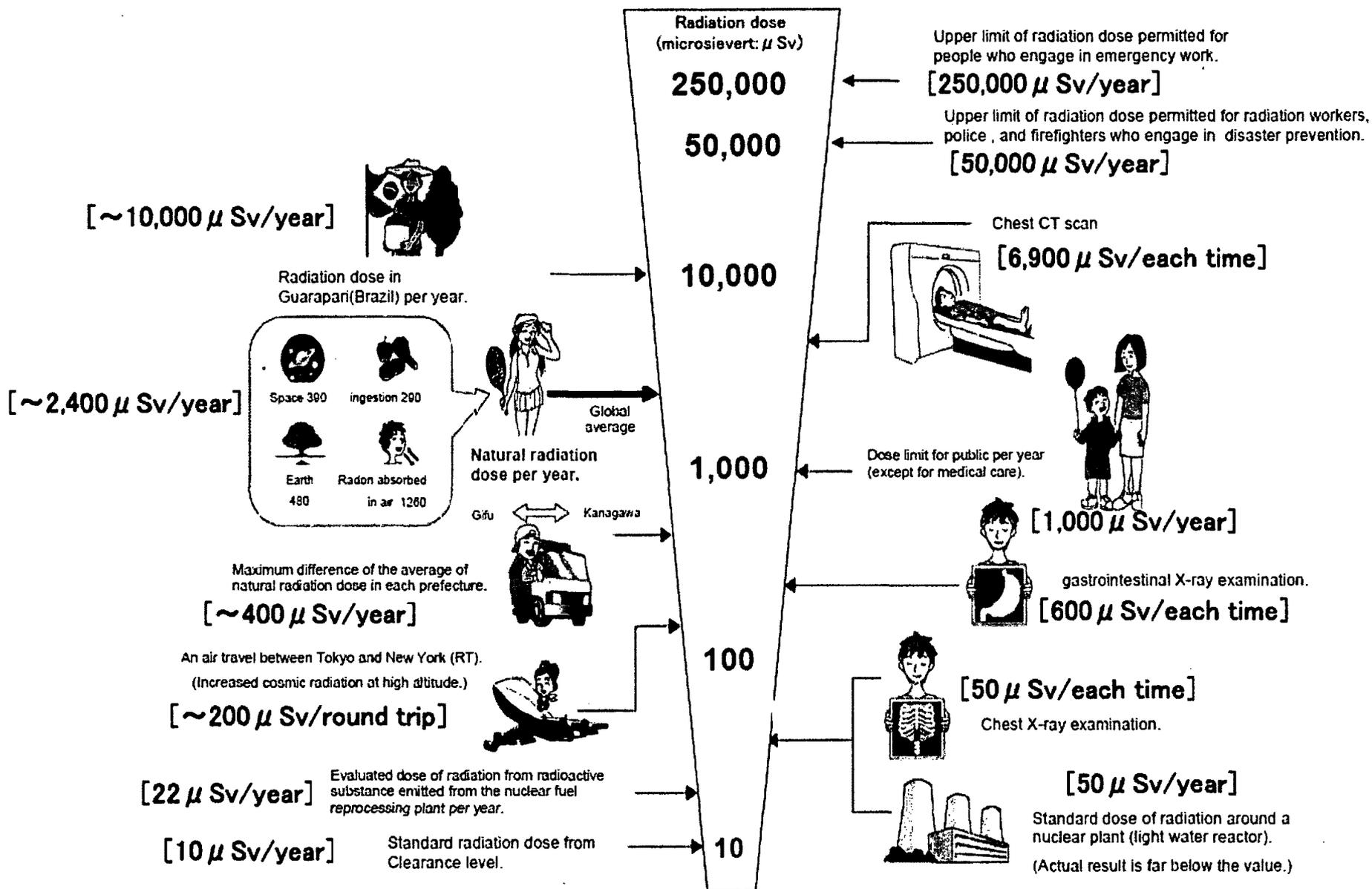
Workers Exposed to Radiation in Fukushima Dai-ichi NPS, as of April 5

level of exposure	number of workers
more than 100mSv	21
more than 250mSv	0

Nuclear and Industrial Safety Agency

*On March 24, three workers exposed to more than 170mSv were hospitalized, but were released four days later after no health problems were found.

Radiation in Daily-life



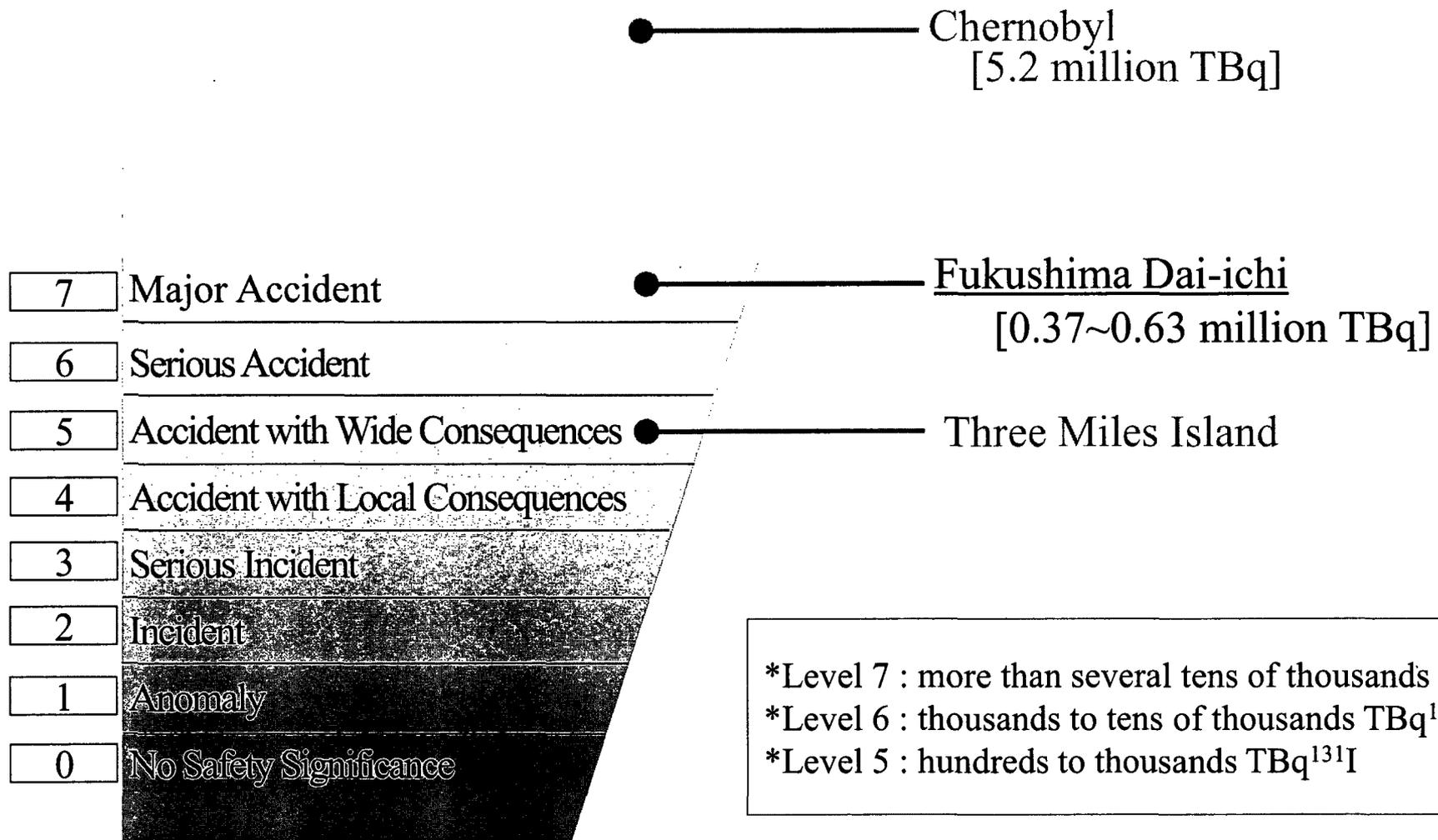
※ Sv [Sievert] = Constant of organism effect by kind of radiation (※) × Gy [gray]

※ It is 1 in case of X ray and γ ray.

MEXT makes this, based on "Nuclear power 2002" made by Agency of Natural Resources and Energy.

INES Rating on the Events in Fukushima Dai-ichi NPS

The Rating of the International Nuclear and Radiological Event Scale (INES) on Fukushima Dai-ichi Nuclear Power Station (NPS), in temporary assessed as Level 7.

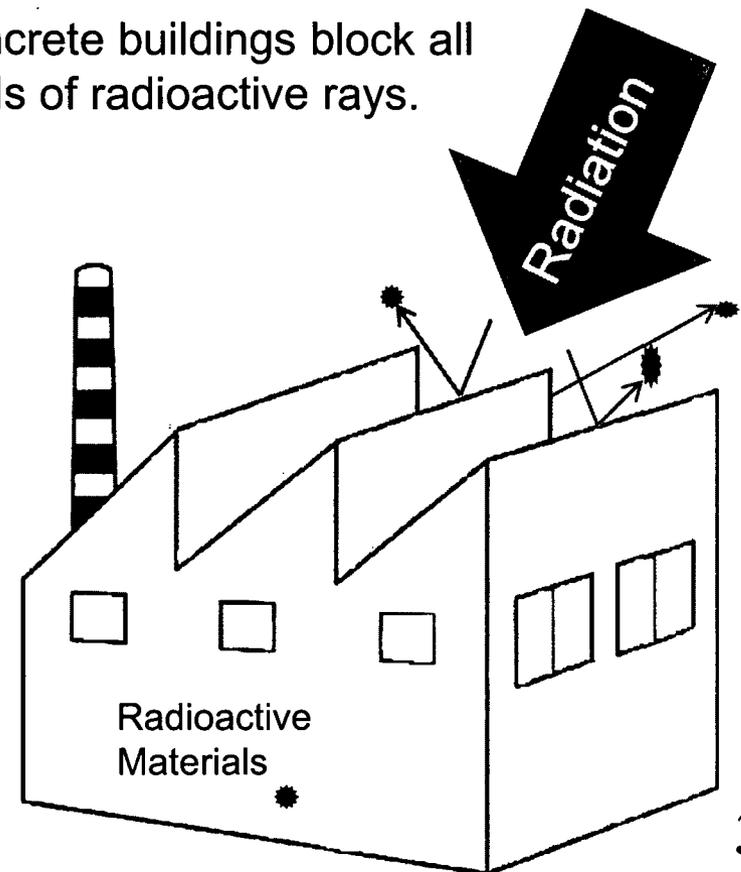
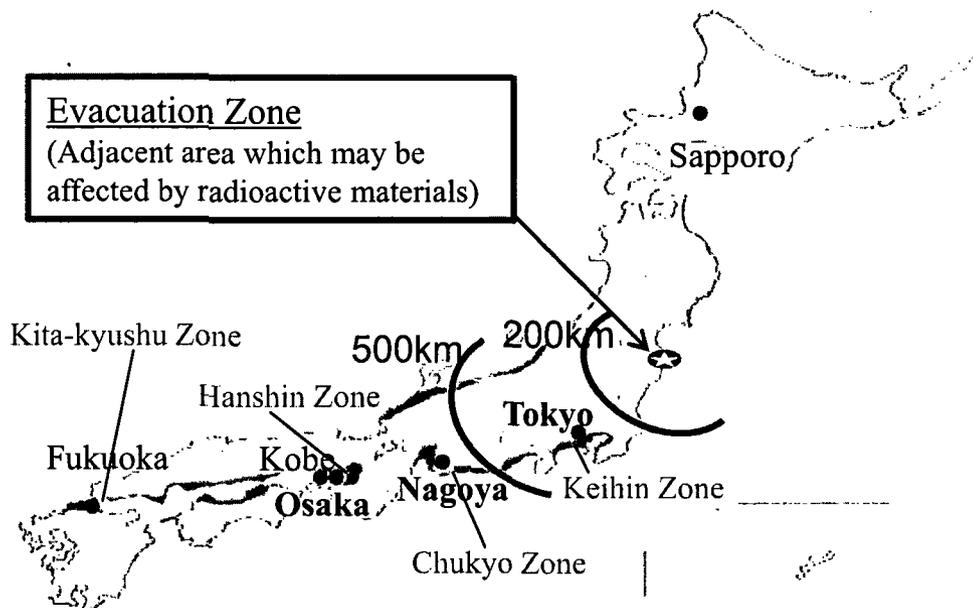


Safety of Industrial Products

- All factories have suspended their operation in the evacuation zone(20 km radius and other designated areas)
- Walls and roofs of factories block radioactive materials and rays.
- Fukushima Dai-ichi is located at least 150 km away from Japanese major industrial zones.

All the operating factories are off the evacuation zone.

Concrete buildings block all kinds of radioactive rays.



Measurement of Radiation Dose around the Metropolitan Airports

The current level of radiation dose of airports in the Tokyo Metropolitan area (Narita and Haneda airports) is at very safe level to health.

Measured dose

http://www.mlit.go.jp/koku/koku_tk7_000003.html

	Measurement points		Apr.14 AM	Apr.14 PM	Apr.15 AM		Annual exposure calculation
Narita Airport	○	Narita Airport	0.116 μ Gy/h 10:00	0.117 μ Gy/h 19:00	0.119 μ Gy/h 10:00	\cong 0.000119 mSv/h	1.04 mSv
Haneda Airport	☆	Haneda Airport (Ukishimacho, Kawasaki City.)	0.085 μ Gy/h 10:00	0.086 μ Gy/h 19:00	0.082 μ Gy/h 10:00	\cong 0.000082 mSv/h	0.72 mSv

1) According to the website of Tokyo-Electric Power Company, the unit is converted as follows;

1 micro-Gray/hour (μ Gy/hr) \cong 1 micro-Sievert /hour (μ Sv/hr).

2) "Annual exposure calculation" is the estimation under the condition that the hourly radiation dose measurement at the measurement point is accumulated for 24 hours throughout the year.

3) 1 mili-Sievert (mSv) = 1000 micro-Sievert (μ Sv)

According to the Ministry of Education, Culture, Sports, Science and Technology, examples of exposure level of radiation in daily life is as below.

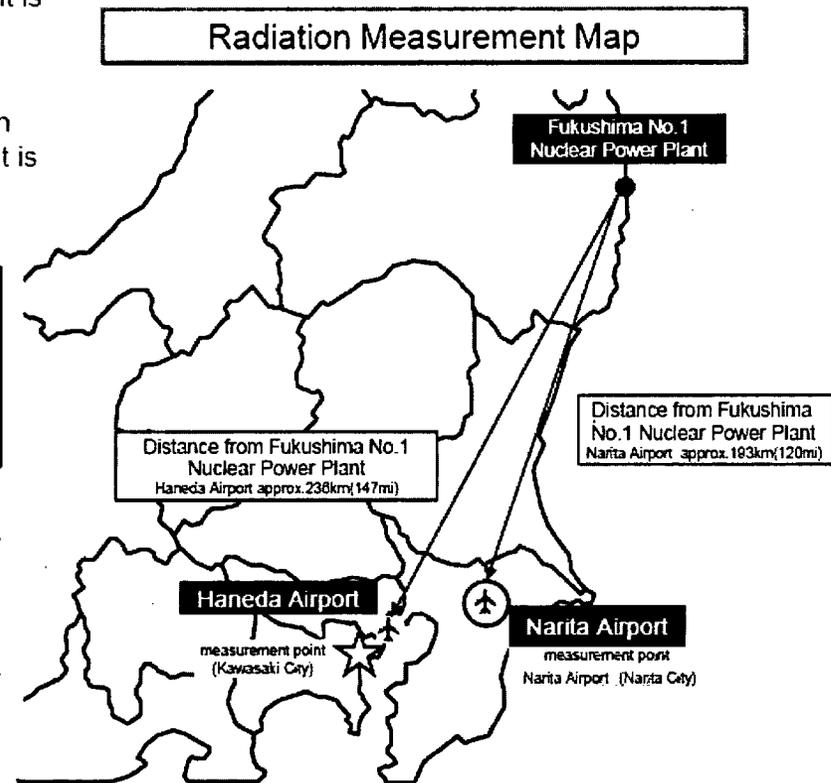
- Chest X-ray (once) 0.05 mSv
- 1 roundtrip between Tokyo and New York by air 0.2 mSv
- Stomach X-ray (once) 0.6 mSv

According to the WHO, a person is exposed to approximately 3.0mSv/year on average.

References:

○	NARITA INTERNATIONAL AIRPORT CORPORATION Website http://contents.narita-airport.jp/narita/en/222.pdf
☆	Kanagawa Environmental-radiation Monitoring-system Website (Japanese only) http://www.atom.pref.kanagawa.jp/cgi-bin2/telemeter_dat.cgi?Area=1&Type=W

Source: Ministry of land, infrastructure and transportation[



Measurement of Radiation Dose in the Ports around Tokyo Bay

The current level of radiation dose of seaports of Tokyo Bay(Ports of Tokyo, Yokohama, Kawasaki and Chiba) is at very safe level to health.

Measured dose

http://www.mlit.go.jp/kowan/kowan_fr1_000041.html

	Measurement points (Address)	Apr,14 AM	Apr,14 PM	Apr,15 AM	Annual exposure calculation	
Port of Tokyo	⊙ Tokyo Metropolitan Institute of Public Health (Hyakunin-cho, Shinjuku-ku, Tokyo)	79nGy/h 8:00	77nGy/h 17:00	78nGy/h 8:00	≈ 0.000078 mSv/h	0.68mSv
Port of Yokohama	☆ Environmental Science Research Institute (Takigashira, Isogo-ku, Yokohama, Kanagawa)	38nGy/h 8:00	37nGy/h 17:00	37nGy/h 8:00	≈ 0.000037 mSv/h	0.32mSv
Port of Kawasaki	△ Kawasaki Municipal Research Institute for Environmental Protection (Tajima-cho, Kawasaki-ku, Kawasaki, Kanagawa)	54nGy/h 8:00	54nGy/h 17:00	53nGy/h 8:00	≈ 0.000053 mSv/h	0.46mSv
Port of Chiba	□ Chiba Prefectural Environmental Research Center (Iwasaki-Nishi, Ichihara, Chiba)	55nGy/h 8:00	53nGy/h 17:00	53nGy/h 8:00	≈ 0.000053 mSv/h	0.46mSv

- 1) According to the website of Tokyo-Electric Power Company, the unit is converted 1 nano-Gray/hour (nGy/hr) \approx 1 nano-Sievert /hour (nSv/hr).
- 2) "Annual exposure calculation" is the estimation under the condition that the hourly radiation dose measurement at the measurement point is accumulated 24 hours throughout the year.
- 3) 1 milli-Sievert (mSv) = 1000 micro-Sievert (μ Sv)
1 micro-Sievert (μ Sv) = 1000 nano-Sievert (nSv)

According to the Ministry of Education, Culture, Sports, Science and Technology, examples of exposure level of radiation in daily life is as below.

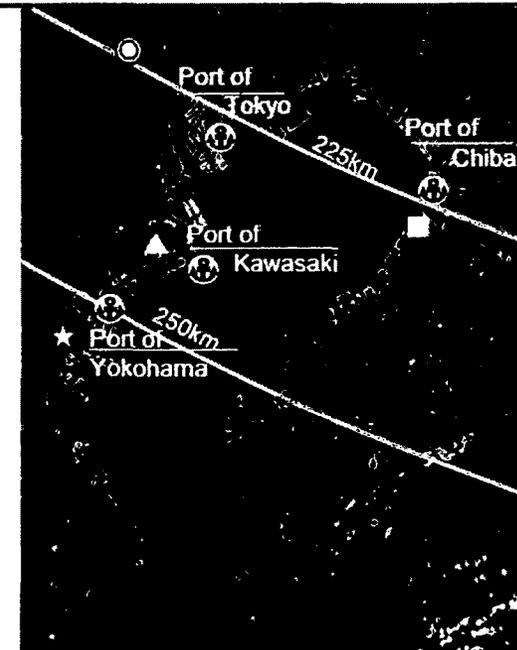
- Chest X-ray (once)	0.05 mSv
- 1 roundtrip between Tokyo and New York by air	0.2 mSv
- Stomach X-ray (once)	0.6 mSv

According to the WHO, a person is exposed to approximately 3.0mSv/year on average.

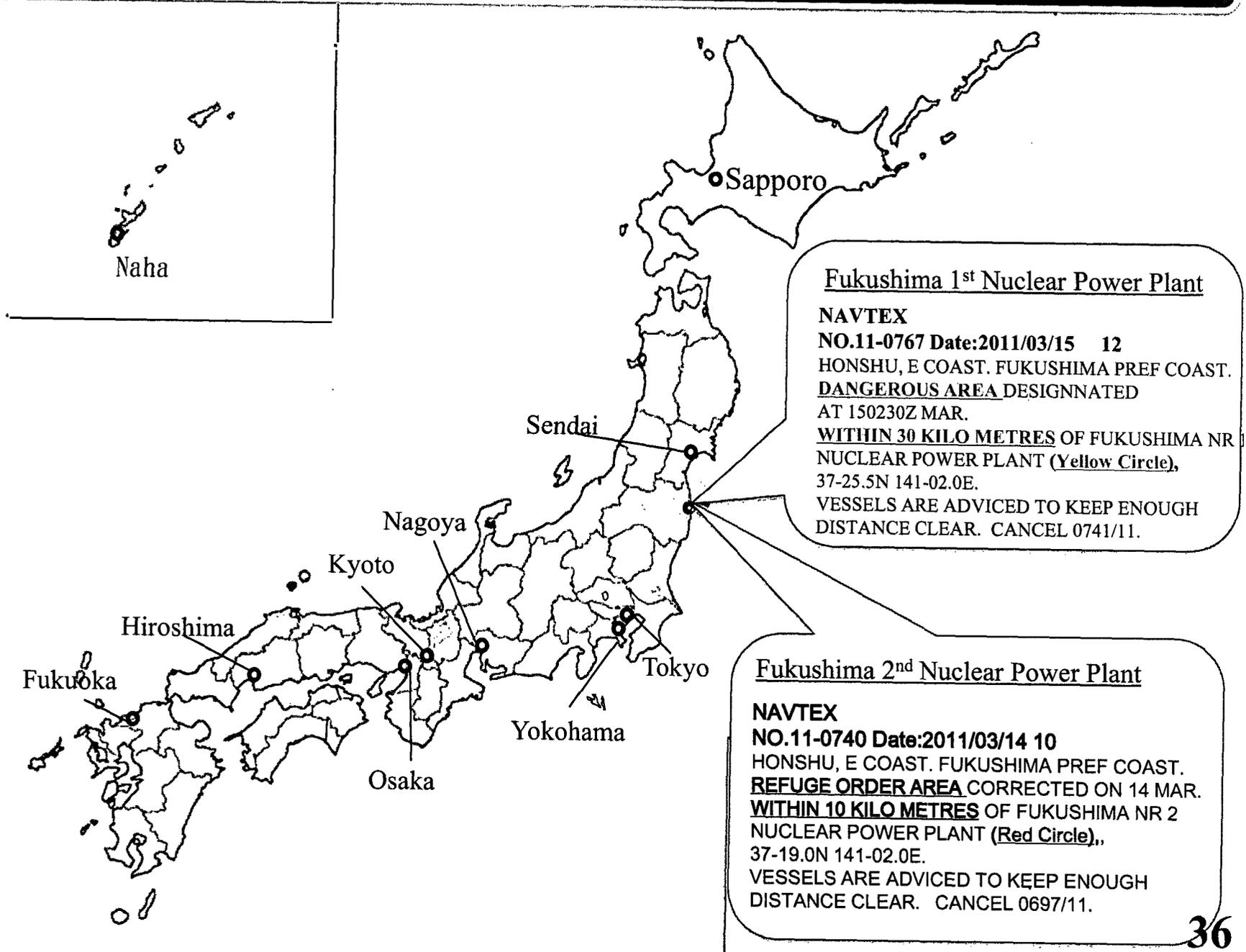
References:

⊙	Tokyo Metropolitan Institute of Public Health Website (Japanese only) http://www.tokyo-eiken.go.jp/monitoring/index.html
☆	City of Yokohama, Environmental Planning Bureau Website(Japanese only) http://www.city.yokohama.lg.jp/kankyo/saigai/
△	City of Kawasaki Website(Japanese only) http://www.city.kawasaki.jp/e-news/info3715/index.html
□	Chiba Prefecture Government Website(Japanese only) http://www.pref.chiba.lg.jp/index.html

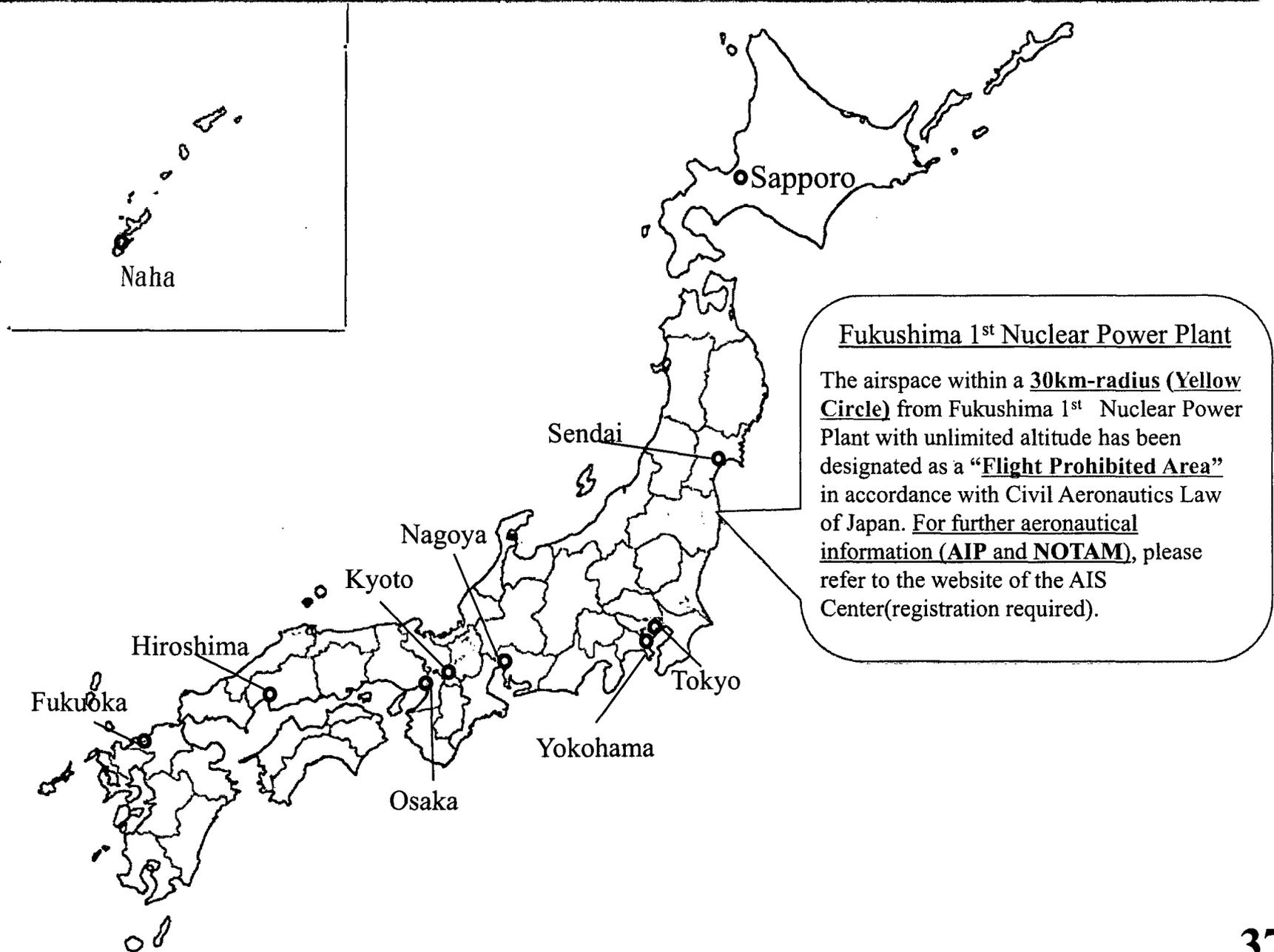
Distance from Fukushima No1 Nuclear Plant



Navigational Warnings (Vessels)



Flight Routes and Airspace



C. Impact on Japanese Economy

1. Estimated Economic Damage of the Tohoku-Pacific Ocean Earthquake and Plan for Reconstruction
2. Impact on Energy Supply/Demand in Japan

1. Estimated Economic Damage of the Tohoku-Pacific Ocean Earthquake and Plan for Reconstruction

Damaged Stocks in Disaster Areas

*estimated by the Cabinet Office of Japan

16~25 trillion Yen
(US\$195~305 billion)

(Reference) Japan's GDP : 500 trillion Yen (US\$5.9 trillion)

Plan for Recovery and Reconstruction

*from the speech of Prime Minister Kan on Apr. 1 and Apr. 12

Short-term: clearing debris, erecting temporary housing,
rehabilitating industrial facilities

Mid and long-term: creating disaster-resilient local community,
eco-friendly social system, and welfare-oriented society

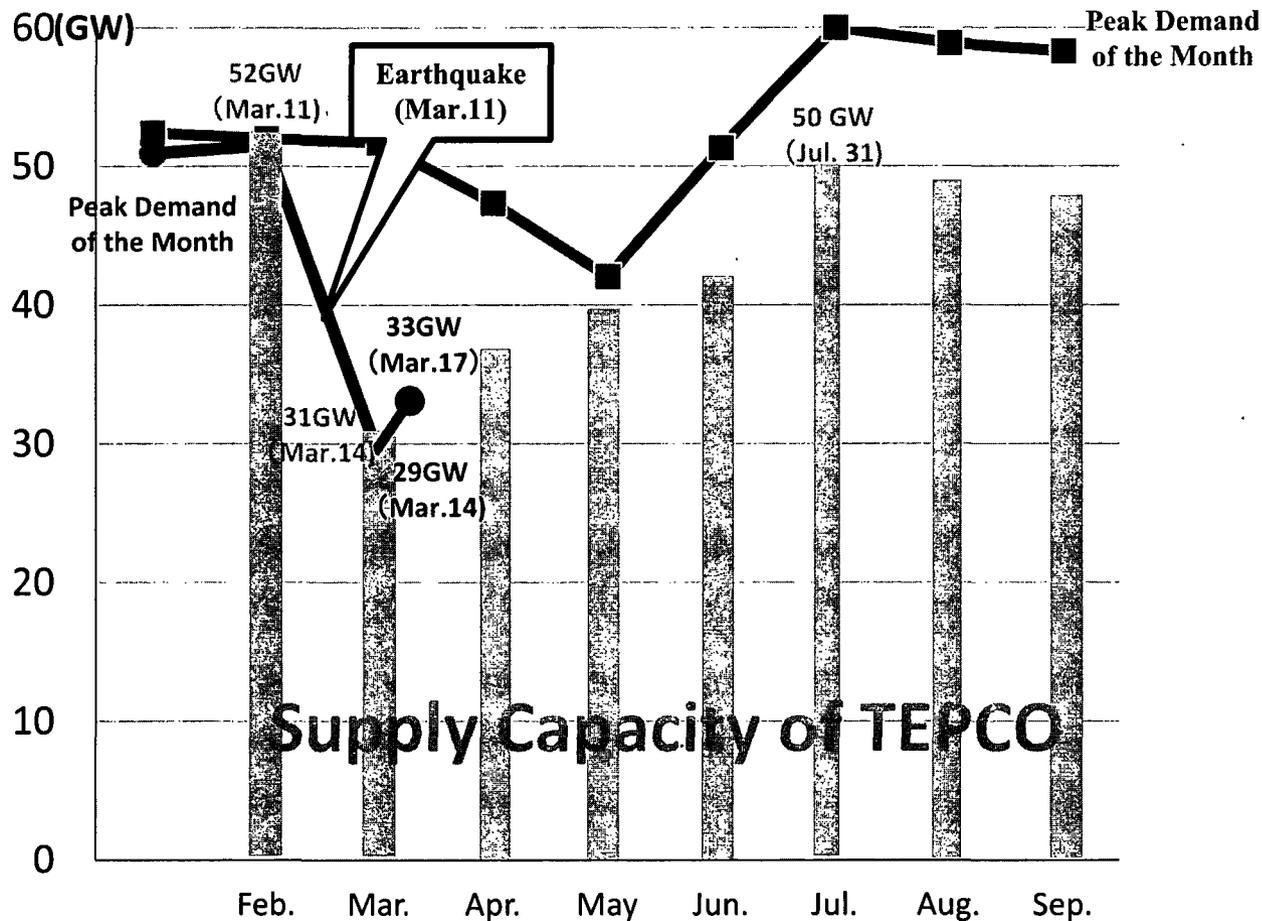
“Reconstruction Planning Council” established

Compiling supplementary budgets and enacting/amending relevant laws

2. Impact on Energy Supply/Demand in Japan

Tokyo Electric Power Company (TEPCO) normally supplies electricity to an area with a population of over 42 million responsible for almost 40% of Japan's GDP, but lost 40% of its generation capacity after the earthquake and tsunami.

We are making the utmost efforts to match supply and demand during the peak-load summer on both the demand side (intensive energy saving and scheduled rolling blackouts) and supply side (capacity expansion of thermal plants).



D. Cooperation and Information sharing with the International Community

1. Cooperation with International Organizations
2. Speedy Dissemination of Accurate Information

Cooperation with the IAEA

1. Information Sharing

- (1) Japan has been providing facility-related and other relevant information to the IAEA.
- (2) Nuclear Industry Safety Agency (NISA) provided updates on situations of the Fukushima Dai-ichi Nuclear Power Station at the IAEA Technical Briefing (21st March) and at the side event of the Fifth Review Meeting of the Contract Parties to the Convention on Nuclear Safety (4th April).

2. IAEA Expert Missions

- (1) The IAEA has extended to Japan upon the request of the Government of Japan, in connection with the incidents involving the nuclear power plants in Japan by dispatching a series of the IAEA experts to Japan mainly in the field of radiation monitoring. Such dispatch of experts includes :
 - (a) Radiation Monitoring Teams, totaling up to 16 members who have been taking measurements mainly in Fukushima since 19 March;
 - (b) one marine expert from the IAEA's laboratory in Monaco, who boarded Research Vessel "MIRAI" during 2 -4 April to observe and provide advice for Japanese experts on their method of collection and analysis of seawater samples; and
 - (c) A Joint FAO/IAEA Food Safety Assessment Team, who met with local government officials, farmers etc. in Fukushima, Ibaraki, Tochigi and Gunma prefecture.
- (2) In addition, IAEA experts in BWR technology met with Japanese officials and operators including NISA and the Tokyo Electric Power Company (TEPCO) and visited the Fukushima Dai-ichi Nuclear Power Plant on 6 April.

Press Release by International Organizations

Airports

ICAO (International Civil Aviation Organization):

“No Restrictions on Travel to Japan” (News release: March 18)

<http://www2.icao.int/en/NewsRoom/Lists/News/DispForm.aspx?ID=37>

“Current Radiation Levels in Japan and Travel Advice” (News release: April 1)

<http://www2.icao.int/en/NewsRoom/Lists/News/DispForm.aspx?ID=39>

“Current Situation for Travel and Transport to and from Japan” (News release: April 14)

<http://www2.icao.int/en/NewsRoom/Lists/News/DispForm.aspx?ID=40>

IATA (International Air Transport Association):

“No Restrictions on Air Travel to Japan” (News release: March 19)

<http://www.iata.org/pressroom/pr/Pages/2011-03-18-02.aspx>

“UN Confirms Safety of Japan Operations - No Recommendation for Passenger Screening” (News release: April 1)

<http://www.iata.org/pressroom/pr/Pages/2011-04-01-01.aspx>

Ports

IMO (International Maritime Organization):

“Current situation for travel and transport to and from Japan” (News release: April 15)

<http://www.imo.org/MediaCentre/PressBriefings/Pages/22-japan-update.aspx>

“Current radiation levels in Japan and travel advice” (News release: April 4)

<http://www.imo.org/MediaCentre/PressBriefings/Pages/17-radiation-.aspx>

“Shipping advised to comply with relevant NAVAREA warnings off Japan” (News release: March 24)

<http://www.imo.org/MediaCentre/PressBriefings/Pages/13-navigation-off-japan.aspx>

“No Restrictions on Travel to Japan” (News release: March 21)

<http://www.imo.org/MediaCentre/PressBriefings/Pages/No-restrictions-on-travel-to-Japan.aspx>

IAPH (The International Association of Ports and Harbours) :

“Japanese ports are safe” (News release: March 25) <http://www.iaphworldports.org/#>

PIANC (The World Association for Waterborne Transport Infrastructure) :

“No fear on port function and people's health” (News release: April 4)

<http://www.pianc.org/downloads/events/Message%20from%20PIANC%20Japan.pdf>

Speedy Dissemination of Accurate Information

- Japan is committed to the speedy dissemination of accurate information.
- All necessary information can be found at the following websites.

Japan's Countermeasures

- 1. <http://www.kantei.go.jp/foreign/incident/index.html>
- 2. <http://www.meti.go.jp/english/index.html>
- 3. <http://www.nisa.meti.go.jp/english/>

Measurement of Radioactivity Level

- 1. http://www.mext.go.jp/english/radioactivity_level/detail/1303962.htm
- 2. <http://www.nisa.meti.go.jp/english/>
- 3. http://www.worldvillage.org/fia/kinkyu_english.php
- 4. <http://www.tepco.co.jp/en/press/corp-com/release/index-e.html>

Drinking Water Safety

- 1. <http://www.mhlw.go.jp/english/topics/2011eq/index.html>
- 2. <http://www.waterworks.metro.tokyo.jp/press/shinsai22/press110324-02-1e.pdf>

Food Safety

- 1. <http://www.maff.go.jp/e/index.html>
- 2. <http://www.mhlw.go.jp/english/topics/2011eq/index.html>

Ports and Airports Safety

- 1. http://www.mlit.go.jp/page/kanbo01_hy_001428.html
- 2. http://www.mlit.go.jp/koku/flyjapan_en/index.html
- 3. http://www.mlit.go.jp/page/kanbo01_hy_001411.html

Greenwood, Carol

From: Gibson, Kathy
Sent: Monday, April 25, 2011 1:19 PM
To: Lee, Richard
Cc: Ramirez, Annie
Subject: SFP study steering committee

Richard,

Please craft an email (or have staff do it) that I would send to appropriate office division directors explaining the study and inviting their participation on a steering committee. I will need the list of offices and DDs to send the email to.

At some appropriate point a meeting of the group will need to be scheduled.

I will also need a draft charter to send for their consideration and comment.

Annie can help with this if you need her assistance.

Thanks,
K

44/529

Ibarra, Jose

From: Rivera-Lugo, Richard
Sent: Monday, April 25, 2011 4:07 PM
To: RES_DE
Cc: Parks, Jazel; Dempsey, Heather
Subject: ACTION: New Expedited FOIA Requests from Greenwire & NRDC (Due May 2nd)
Attachments: Greenwire FOIA Request.pdf; NRDC FOIA Request.pdf; Quick Reference - FOIA Exemptions_Rev1.pdf

Importance: High

DE Staff,

All RES divisions have been task with two (2) new expedited FOIA Requests from Greenwire & the Natural Resource Defense Council (NRDC).

Please provide ALL documentation (This includes all e-mails, faxes, written correspondences, meeting minutes, memos, studies, analyses, etc.) pertaining to the Japanese events **during the period of March 11th through April 20th, 2011.**

Instructions for the Greenwire & NRDC FOIA requests:

1. If you already submitted your records for the previous FOIA requests listed below, you **DO NOT need to re-submit the records for the dates that were covered by those requests.**
 - AP FOIA: March 11 - 16, 2011
 - Greenpeace FOIA: March 11 - 24, 2011
 - Kyodo News FOIA: March 11 – April 11, 2011
2. For e-mail records, **provide only the communications that you have sent addressing the Japanese events (Sent folder).** You only have to provide items from your inbox (received e-mails) if they were sent by any person, organization or agency outside of NRC.
3. The FOIA Office has requested the staff to submit all records in **hard copies, printed single-sided.**
4. **Make sure to mark in your records any exemptions that might apply to information that, in your opinion, should not be released to the public** (e.g. pre-decisional information, personal identifiable information, proprietary information, etc). Please follow the guidance on the "*How to Respond to a FOIA Request*" document. A "Quick Reference to FOIA Exemptions" is attached for your convenience.
5. Along with your records package, **include a sheet with your name, time spent responding to this FOIA request, and a note indicating if your submission of records is partial or final.** Packages should be dropped off at the "DE's FOIA Corner" located in front of Mike Case's office (CSB-5 A05).

More information on the active FOIA requests for RES can be found accessing the link below.
<http://www.internal.nrc.gov/RES/FOIA/index.htm>

Please use TAC# **ZF0001** to record your time in HRMS related to activities in response to a FOIA request.

Provide hard copies only of any records that meet the above criteria by 1:00 PM on Monday, May 2nd.

YH/530

If you have any questions please contact me or Jazel Parks, and we will do our best to address your concerns.

Thanks,
Richie

Richard Rivera-Lugo, EIT, MEM
Technical Assistant (Acting)
U.S. Nuclear Regulatory Commission – HQ
RES/DE
Ph. 301-251-7652
Fax 301-251-7420
Mail M.S. C5C07M
E-mail Richard.Rivera-Lugo@nrc.gov

 Please consider the Environment before printing this e-mail.

Coe, Doug

From: Correia, Richard
Sent: Tuesday, April 26, 2011 8:36 AM
To: Sheron, Brian; Uhle, Jennifer; Flory, Shirley
Cc: Coe, Doug; Nelson-Wilson, Carlyleamaryllis; Siu, Carolyn; Hudson, Daniel
Subject: Supporting the EOC

Brian. Jennifer. I will be working in the EOC starting tomorrow on the 3 - 11 shift and will telework from home for a few hours during the day. I'm on this shift from Wed thru Sun and will probably be off Mon. Doug will be in during these days. His shift work will be in May.

Richard Correia, Director
Division of Risk Analysis
RES

Sent from a Blackberry

44/531

Stutzke, Martin

From: Stutzke, Martin
Sent: Tuesday, April 26, 2011 2:58 PM
To: Kauffman, John; Dube, Donald
Cc: Weerakkody, Sunil
Subject: RE: draft

After rereading the draft that Don provided on April 20th, which included brief discussions about the Fukushima event and the need to assess spent fuel pool accidents, I have reconsidered the opinion expressed in my email earlier today. I will concur on Don's draft (or similar language), and don't see a need to discuss further either face-to-face or via telecom.

Marty

From: Kauffman, John
Sent: Tuesday, April 26, 2011 12:13 PM
To: Dube, Donald
Cc: Weerakkody, Sunil; Stutzke, Martin
Subject: RE: draft.

Yes, I will schedule a meeting. JVK

From: Dube, Donald
Sent: Tuesday, April 26, 2011 11:30 AM
To: Stutzke, Martin; Weerakkody, Sunil; Kauffman, John
Subject: RE: draft

ok

sounds like we have some differences in views and should schedule a meeting, John?

Don

From: Stutzke, Martin
Sent: Tuesday, April 26, 2011 10:28 AM
To: Weerakkody, Sunil; Dube, Donald; Kauffman, John
Subject: RE: draft

Sunil, Don, and John –

I've read the latest version of the memo (ML091880327) and its enclosure (ML091880406) that John provided in his email of April 20th, and believe that they should be issued as-is because they are responsive to the original request stemming from the SOARCA work and MD 6.4. I don't see a specific need to discuss the recent Japanese event since it simply reinforces the original concerns that lead to the request for a GI on multi-unit risk. Several initiatives have been raised concerning spent fuel risk (e.g., Commissioners Apostolakis and Svinicki have requested a briefing, and Brian Sheron is interested in examining the potential risks benefits of off-loading fuel from the spent fuel pool into dry casks). As a result, the issue of spent fuel pool risk is receiving high-level management attention, and I don't see the need to include it into the multi-unit risk pre-GI screening memo or its enclosure.

Marty

44/532

From: Weerakkody, Sunil
Sent: Thursday, April 21, 2011 8:03 AM
To: Dube, Donald; Kauffman, John; Stutzke, Martin
Subject: RE: draft

Don,

Thank you. I agree with all of your suggested changes. Once Marty renders his opinion, we should move forward. Once I hear from Marty, I will send a note to the task force (Jack Grobe, Gary Holahan, Charlie Miller). We should give a heads up to Brian Sheron also.

I will not proceed until I hear from Marty.

Sunil

From: Dube, Donald
Sent: Wednesday, April 20, 2011 3:08 PM
To: Kauffman, John; Weerakkody, Sunil; Stutzke, Martin
Subject: draft

I don't think we can not include broader discussion surrounding Japan and spent fuel pools.

Don

Marty

From: Helton, Donald

Sent: Friday, April 22, 2011 1:55 PM

To: Ghosh, Tina; Fuller, Edward

Cc: Stutzke, Martin

Subject: RE: Proposal to Review SAMA info for input to the NRC 90-day Review

Tina,

I had several positive and cautionary knee-jerk reactions to the PNL writeup (some technical, some programmatic) as follows:

Generic:

- I recommend forwarding PNL's writeup to Jerry Dozier and John Parillo of NRR/DRA as an FYI, in case Ray/Donnie have not thought to share it with them. I believe they have some of the current/future SAMA reviews.
- I've cc'd Marty Stutzke, as I know him to have a general interest in the SAMA analyses as a potential source of information on Level 3 PRA.
- Organizationally, SAMAs (like the AMGs) fall in a "seam" of RES' current organizational structure, and it isn't obvious to me who would push such a thing, barring significant personal interest and ownership on someone's part.

Positive:

- What is proposed seems similar (in a good way) to the IPE and IPEEE "insights" documents (NUREG-1560 and NUREG-1742). As such, it could provide a good desk reference to a variety of folks. Particular examples that come to mind are (i) some of the folks here in DRA involved in the early planning for the new site Level 3 PRA project, (ii) the folks, like Ed, doing SAMDA reviews in NRO, and (iii) the INL SPAR model developers when looking for a sanity check on the relative contribution to CDF of various initiators for specific plants.

Cautionary:

- I recall you telling me that ISL does some of the SAMA reviews. Is PNL in a position of having uniform knowledge or the 50 or so SAMA analyses that have been done?
- The paper rightfully points out the maturity of internal events PRA relative to external events PRA. What is interesting is that the paper does not emphasize how this disparity affects SAMA analyses. The SAMA analyses also have a much higher pedigree on the internal events front, and at the extreme (as I recall), use a multiplier to estimate external event risk based on ratioing of IPE to IPEEE results. If the paper is going to place such emphasis on how the SAMA results are valuable to external event risk contemplation, it should also discuss some of these shortcomings.
- One should be very careful in treating the SAMA results as if they are the same as Level 3 PRAs whose end-use was the realistic quantification of present risk. As you know, there are a number of process-related assumptions and simplifications that go in to the SAMA analyses (generally resulting from the fact that SAMAs are part of the environmental review and the fact that they are by definition value/impact assessments). I think it would be easy to lose sight of how these assumptions and simplifications affect the final results.
- Building on the thought above, the quality of the SAMA analyses naturally varies from licensee to licensee. Since PRA models used for SAMA are not required to meet the PRA standard and are not industry peer-reviewed (but rather their results are reviewed by the staff and its contractors), I would be very wary of compiling information across licensees given that it implies (if not demands) comparability in quality.
- Finally, and again related to the two points above, the SAMAs are a snapshot in time, ranging from some that were performed in the late 90s to some that are yet to be done. This is different than the case for IPE/IPEEEs (recognizing that there was some time lapse even with those). Again, comparability implied by compilation is suspect.

Best,
Don

From: Ghosh, Tina
Sent: Friday, April 22, 2011 11:50 AM
To: Helton, Donald; Fuller, Edward
Subject: FW: Proposal to Review SAMA info for input to the NRC 90-day Review

Dear Don and Ed,

Attached please find a white paper from PNNL with ideas on how to leverage SAMA information for NRC's post-Fukushima look. Steve Short who transmitted it is currently the PI on the only existing contract for NRR/DRA SAMA reviews. Garill Coles is a level 1 PRA information reviewer for SAMAs. (The paper has already been shared with NRR/DRA).

Maybe it is a little late in the process but wanted to pass it along in case you wanted to pursue any work with PNNL on the topic, or if you are involved in NRC's task force work. Bob Palla and I had intended to have PNNL help compile the information discussed in the white paper but due to higher priority work, it was always put on the back burner and then Bob retired and I moved to another NRC position...

Anyway, let me know if you have any interest and want to discuss.

Thanks, and hope all is well,
Tina

S. Tina Ghosh, Ph.D.
Senior Program Manager
Division of Systems Analysis
Office of Nuclear Regulatory Research
U.S. Nuclear Regulatory Commission
Mail Stop: C-3A07M
Washington, DC 20555
Phone: 301-251-7984

From: Short, Steve M [mailto:steve.short@pnl.gov]
Sent: Thursday, April 14, 2011 9:54 PM
To: Ghosh, Tina
Cc: Coles, Garill A; Gallucci, Ray
Subject: Proposal to Review SAMA info for input to the NRC 90-day Review

Hi Tina:

How are you doing and how is SOARCA going? I hope all is well with you and your family.

I wanted to get your thoughts on a white paper we have developed that we feel could provide useful insight into the NRC review of the safety of U.S. plants in response to the recent events in Japan. The white paper is attached. Basically the white paper proposes that the severe accident information provided with the license renewal SAMA analyses provides significant insight into both the internal and external risk at 4/5 of nuclear power plants in the U.S and that this risk information would have value to the NRC review

that the NRC commission initiated a couple of weeks ago. A couple of years ago Bob Palla and I discussed the potential for compiling this information and I believe he discussed doing something along these lines with you. The attached white paper proposes an expanded version of what we had previously discussed. I would appreciate your thoughts on the white paper proposal and whether you consider it is worth pressing forward with. Any comments/thoughts you have would be much appreciated.

FYI. We have provided this to Ray Gallucci and Donnie Harrison. We've updated it to include Ray's comments but unfortunately we have not been able to get any feedback from Donnie (it is my understanding he has been busy working at the NRC emergency control center). However, we also recognize that this proposal is more likely to be of interest to RES than to NRR so I'm hoping you will give me your thoughts.

Thanks much.

Steve

Steven Short, P.E.

Staff Engineer

Energy and Environment Directorate

Pacific Northwest National Laboratory

902 Battelle Boulevard

P.O. Box 999, MSIN K6-52

Richland, WA 99352 USA

Tel: 509-375-2868

Fax: 509-372-4995

steve.short@pnl.gov

www.pnl.gov

INFORMATION FROM THE REVIEW OF SAMAS

Last Update: April 18, 2011

Plant	Docket Number	NRC Region	Type	NSSS	Containment	NSSS Details	MWt	MWe	GI-199	license	Internal	population	offsite		
									Safety/Risk Assessment	renewal	events CDF	dose risk	economic cost risk	p-rem per accident	offsite cost per accident
									screening	status	per year	p-rem/y	\$/y		
Arkansas Nuclear 1	05000313	4	PWR	B&W	PWR-DRYAMB	B&W LLP	2568	843	exclude	completed	1.10E-05	5.53E-01	9.56E+02	5.03E+04	8.69E+07
Arkansas Nuclear 2	05000368	4	PWR	CE	PWR-DRYAMB	CE	3026	995	exclude	completed	7.20E-06	1.72E+00	3.39E+03	2.39E+05	4.70E+08
Beaver Valley 1	05000334	1	PWR	WEST	PWR-DRYAMB	WEST 3LP	2900	892	exclude	completed	1.96E-05	5.79E+01	not stated	2.95E+06	1.65E+10
Beaver Valley 2	05000412	1	PWR	WEST	PWR-DRYAMB	WEST 3LP	2900	846	exclude	completed	2.40E-05	5.58E+01	not stated	2.33E+06	1.32E+10
Braidwood 1	05000456	3	PWR	WEST	PWR-DRYAMB	WEST 4LP	3586.6	1178	exclude						
Braidwood 2	05000457	3	PWR	WEST	PWR-DRYAMB	WEST 4LP	3586.6	1152	exclude						
Browns Ferry 1	05000259	2	BWR	GE	BWR-MARK 1	GE 4	3458	1065	exclude	completed					
Browns Ferry 2	05000260	2	BWR	GE	BWR-MARK 1	GE 4	3458	1104	exclude	completed	2.62E-06	1.64E+00	1.97E+03	6.26E+05	7.50E+08
Browns Ferry 3	05000296	2	BWR	GE	BWR-MARK 1	GE 4	3458	1115	exclude	completed	3.36E-06	1.95E+00	2.14E+03	5.80E+05	6.37E+08
Brunswick 1	05000325	2	BWR	GE	BWR-MARK 1	GE 4	2923	938	exclude	completed	4.19E-05	2.94E+01	4.85E+04	7.00E+05	1.16E+09
Brunswick 2	05000324	2	BWR	GE	BWR-MARK 1	GE 4	2923	937	exclude	completed	4.19E-05	2.94E+01	4.85E+04	7.00E+05	1.16E+09
Byron 1	05000454	3	PWR	WEST	PWR-DRYAMB	WEST 4LP	3586.6	1164	exclude						
Byron 2	05000455	3	PWR	WEST	PWR-DRYAMB	WEST 4LP	3586.6	1136	exclude						
Callaway	05000483	4	PWR	WEST	PWR-DRYAMB	WEST 4LP	3565	1236	exclude	letter of intent					
Calvert Cliffs 1	05000317	1	PWR	CE	PWR-DRYAMB	CE	2700	873	exclude	completed	3.30E-04	6.86E+01	6.91E+04	2.08E+05	2.09E+08
Calvert Cliffs 2	05000318	1	PWR	CE	PWR-DRYAMB	CE	2700	862	exclude	completed	3.30E-04	6.86E+01	6.91E+04	2.08E+05	2.09E+08
Catawba 1	05000413	2	PWR	WEST	PWR-ICECND	WEST 4LP	3411	1129	exclude	completed	5.80E-05	3.14E+01	NUREG/BR-0184	5.41E+05	n/a
Catawba 2	05000414	2	PWR	WEST	PWR-ICECND	WEST 4LP	3411	1129	exclude	completed	5.80E-05	3.14E+01	NUREG/BR-0184	5.41E+05	n/a
Clinton	05000461	3	BWR	GE	BWR-MARK 3	GE 6	3473	1065	exclude						
Columbia	5000397	4	BWR	GE	BWR-MARK 2	GE 5	3486	1190	not in scope	under review	4.80E-06	3.68E+00	6.14E+03	7.67E+05	1.28E+09
Comanche Peak 1	05000445	4	PWR	WEST	PWR-DRYAMB	WEST 4LP	3612	1200	exclude						
Comanche Peak 2	05000446	4	PWR	WEST	PWR-DRYAMB	WEST 4LP	3458	1150	exclude						
Cooper	05000298	4	BWR	GE	BWR-MARK 1	GE 4	2419	830	exclude	completed	1.16E-05	2.14E+00	7.01E+03	1.84E+05	6.04E+08
Crystal River 3	05000302	2	PWR	B&W	PWR-DRYAMB	B&W LLP	2609	838	continue	under review	4.99E-06	3.98E+00	6.95E+03	7.98E+05	1.39E+09
D.C. Cook 1	05000315	3	PWR	WEST	PWR-ICECND	WEST 4LP	3304	1009	exclude	completed	4.99E-05	4.25E+01	6.46E+04	8.53E+05	1.30E+09
D.C. Cook 2	05000316	3	PWR	WEST	PWR-ICECND	WEST 4LP	3468	1060	exclude	completed	4.99E-05	4.25E+01	6.46E+04	8.53E+05	1.30E+09
Diablo Canyon 1	5000275	4	PWR	WEST	PWR-DRYAMB	WEST 4LP	3411	1120	not in scope	under review	8.44E-06	8.79E+00	3.37E+04	1.04E+06	3.99E+09
Diablo Canyon 2	5000323	4	PWR	WEST	PWR-DRYAMB	WEST 4LP	3411	1120	not in scope	under review	8.44E-06	8.79E+00	3.37E+04	1.04E+06	3.99E+09
Davis-Besse	05000346	3	PWR	B&W	PWR-DRYAMB	B&W LLP	2817	893	exclude	under review	9.20E-06	2.00E+00	1.60E+03	2.17E+05	1.74E+08
Dresden 2	05000237	3	BWR	GE	BWR-MARK 1	GE 3	2957	867	continue	completed	1.90E-06	1.02E+01	1.84E+04	5.38E+06	9.69E+09
Dresden 3	05000249	3	BWR	GE	BWR-MARK 1	GE 3	2957	867	continue	completed	1.90E-06	1.02E+01	1.84E+04	5.38E+06	9.69E+09
Duane Arnold	05000331	3	BWR	GE	BWR-MARK 1	GE 4	1912	640	continue	completed	1.08E-05	1.98E+01	7.67E+04	1.83E+06	7.10E+09
Farley 1	05000348	2	PWR	WEST	PWR-DRYAMB	WEST 3LP	2775	851	continue	completed	3.35E-05	1.21E+00	1.82E+03	3.62E+04	5.44E+07
Farley 2	05000364	2	PWR	WEST	PWR-DRYAMB	WEST 3LP	2775	860	continue	completed	3.35E-05	1.21E+00	1.82E+03	3.62E+04	5.44E+07
Fermi 2	05000341	3	BWR	GE	BWR-MARK 1	GE 4	3430	1122	exclude						
FitzPatrick	05000333	1	BWR	GE	BWR-MARK 1	GE 4	2536	852	exclude	completed	2.74E-06	1.63E+00	3.30E+03	5.95E+05	1.20E+09
Fort Calhoun	05000285	4	PWR	CE	PWR-DRYAMB	CE	1500	482	exclude	completed	2.48E-05	1.02E+01	1.54E+04	4.09E+05	6.22E+08
Ginna	05000244	1	PWR	WEST	PWR-DRYAMB	WEST 2LP	1775	498	exclude	completed	3.97E-05	4.09E+00	2.41E+04	1.03E+05	6.07E+08
Grand Gulf 1	05000416	4	PWR	GE	BWR-MARK 3	GE 6	3898	1297	exclude	letter of intent					
Harris 1	05000400	2	BWR	WEST	PWR-DRYAMB	WEST 3LP	3900	900	exclude	completed	9.24E-06	2.90E+01	4.30E+04	3.14E+06	4.66E+09
Hatch 1	05000321	2	BWR	GE	BWR-MARK 1	GE 4	2804	876	exclude	completed	1.64E-05	3.37E+00	9.26E+03	2.06E+05	5.65E+08
Hatch 2	05000366	2	BWR	GE	BWR-MARK 1	GE 4	2804	883	exclude	completed	1.64E-05	3.37E+00	9.26E+03	2.06E+05	5.65E+08
Hope Creek 1	05000354	1	BWR	GE	BWR-MARK 1	GE 4	3840	1061	exclude	under review	6.11E-06	2.29E+01	1.55E+05	3.74E+06	2.54E+10
Indian Point 2	05000247	1	PWR	WEST	PWR-DRYAMB	WEST 4LP	3216	1020	continue	under review	1.79E-05	2.20E+01	4.49E+04	1.23E+06	2.51E+09
Indian Point 3	05000286	1	PWR	WEST	PWR-DRYAMB	WEST 4LP	3216	1025	continue	under review	1.15E-05	2.45E+01	5.28E+04	2.13E+06	4.59E+09
Kewaunee	05000305	3	PWR	WEST	PWR-DRYAMB	WEST 2LP	1772	556	exclude	completed	8.09E-05	3.02E+01	4.97E+04	3.73E+05	6.14E+08
La Salle 1	05000373	3	BWR	GE	BWR-MARK 2	GE 5	3489	1118	exclude						
La Salle 2	05000374	3	BWR	GE	BWR-MARK 2	GE 5	3489	1120	exclude						
Limerick 1	05000352	1	BWR	GE	BWR-MARK 2	GE 4	3458	1134	continue	letter of intent					

INFORMATION FROM THE REVIEW OF SAMAS

Last Update: April 18, 2011

Plant	Docket Number	NRC Region	Type	NSSS	Containment	NSSS Details	MWT	MWe	GI-199	license	Internal	population	offsite		
									Safety/Risk Assessment screening	renewal status	events CDF per year	dose risk p-rem/y	economic cost risk \$/y	p-rem per accident	offsite cost per accident
Limerick 2	05000353	1	BWR	GE	BWR-MARK 2	GE 4	3458	1134	continue	letter of intent					
McGuire 1	05000369	2	PWR	WEST	PWR-ICECND	WEST 4LP	3411	1100	exclude	completed	4.90E-05	1.35E+01	NUREG/BR-0184	2.76E+05	n/a
McGuire 2	05000370	2	PWR	WEST	PWR-ICECND	WEST 4LP	3411	1100	exclude	completed	4.90E-05	1.35E+01	NUREG/BR-0184	2.76E+05	n/a
Millstone 2	05000336	1	PWR	CE	PWR-DRYAMB	CE	2700	884	exclude	completed	7.17E-05	1.74E+01	not stated	2.43E+05	n/a
Millstone 3	05000423	1	PWR	WEST	PWR-DRYSUB	WEST 4LP	3650	1227	exclude	completed	2.57E-05	1.28E+01	not stated	4.98E+05	n/a
Monticello	05000263	3	BWR	GE	BWR-MARK 1	GE 3	1775	572	exclude	completed	4.47E-05	3.80E+01	2.54E+05	8.49E+05	5.67E+09
Nine Mile Point 1	05000220	1	BWR	GE	BWR-MARK 1	GE 2	1850	621	exclude	completed	2.70E-05	2.25E+01	8.60E+04	8.33E+05	3.19E+09
Nine Mile Point 2	05000410	1	BWR	GE	BWR-MARK 2	GE 5	3467	1140	exclude	completed	6.20E-05	5.09E+01	1.25E+05	8.21E+05	2.02E+09
North Anna 1	05000338	2	PWR	WEST	PWR-DRYSUB	WEST 3LP	2893	903	continue	completed	3.50E-05	2.50E+01	4.88E+04	7.14E+05	1.40E+09
North Anna 2	05000339	2	PWR	WEST	PWR-DRYSUB	WEST 3LP	2893	903	continue	completed	3.50E-05	2.50E+01	4.88E+04	7.14E+05	1.40E+09
Oconee 1	05000269	2	PWR	B&W	PWR-DRYAMB	B&W LLP	2568	846	continue	completed	8.90E-05	4.92E+00	not considered	5.53E+04	
Oconee 2	05000270	2	PWR	B&W	PWR-DRYAMB	B&W LLP	2568	846	continue	completed	8.90E-05	4.92E+00	not considered	5.53E+04	
Oconee 3	05000287	2	PWR	B&W	PWR-DRYAMB	B&W LLP	2568	846	continue	completed	8.90E-05	4.92E+00	not considered	5.53E+04	
Oyster Creek	05000219	1	BWR	GE	BWR-MARK 1	GE 2	1930	619	exclude	completed	1.05E-05	3.60E+01	1.18E+05	3.43E+06	1.12E+10
Palisades	05000255	3	PWR	CE	PWR-DRYAMB	CE	2565	778	exclude	completed	4.05E-05	3.19E+01	1.25E+05	7.88E+05	3.09E+09
Palo Verde 1	5000528	4	PWR	CE	PWR-DRYAMB	CE80-2L	3990	1335	not in scope	under review	5.07E-06	1.36E+01	1.49E+04	2.69E+06	2.94E+09
Palo Verde 2	5000529	4	PWR	CE	PWR-DRYAMB	CE80-2L	3990	1335	not in scope	under review	5.07E-06	1.36E+01	1.49E+04	2.69E+06	2.94E+09
Palo Verde 3	5000530	4	PWR	CE	PWR-DRYAMB	COMB CE80-2L	3990	1335	not in scope	under review	5.07E-06	1.36E+01	1.49E+04	2.69E+06	2.94E+09
Peach Bottom 2	05000277	1	BWR	GE	BWR-MARK 1	GE 4	3514	1112	continue	completed	4.50E-06	1.47E+01	5.17E+04	3.27E+06	1.15E+10
Peach Bottom 3	05000278	1	BWR	GE	BWR-MARK 1	GE 4	3514	1112	continue	completed	4.50E-06	1.47E+01	5.17E+04	3.27E+06	1.15E+10
Perry 1	05000440	3	BWR	GE	BWR-MARK 3	GE 6	3758	1235	continue	letter of intent					
Pilgrim 1	05000293	1	BWR	GE	BWR-MARK 1	GE 3	2028	685	exclude	under review	6.41E-06	1.36E+01	4.59E+04	2.12E+06	7.16E+09
Point Beach 1	05000266	3	PWR	WEST	PWR-DRYAMB	WEST 2LP	1540	512	exclude	completed	3.59E-05	1.83E+00	2.59E+03	5.10E+04	7.23E+07
Point Beach 2	05000301	3	PWR	WEST	PWR-DRYAMB	WEST 2LP	1540	514	exclude	completed	3.59E-05	1.83E+00	2.59E+03	5.10E+04	7.23E+07
Prairie Island 1	05000282	3	PWR	WEST	PWR-DRYAMB	WEST 2LP	1650	551	exclude	under review	9.79E-06	2.94E+00	1.59E+04	3.00E+05	1.62E+09
Prairie Island 2	05000306	3	PWR	WEST	PWR-DRYAMB	WEST 2LP	1650	545	exclude	under review	9.79E-06	2.94E+00	1.59E+04	3.00E+05	1.62E+09
Quad Cities 1	05000254	3	BWR	GE	BWR-MARK 1	GE 3	2957	867	exclude	completed	2.19E-06	1.67E+00	2.81E+03	7.63E+05	1.28E+09
Quad Cities 2	05000265	3	BWR	GE	BWR-MARK 1	GE 3	2957	869	exclude	completed	2.19E-06	1.67E+00	2.81E+03	7.63E+05	1.28E+09
River Bend 1	05000458	4	BWR	GE	BWR-MARK 3	GE 6	3091	989	continue	letter of intent					
Robinson 2	05000261	2	PWR	WEST	PWR-DRYAMB	WEST 3LP	2339	710	exclude	completed	4.23E-05	5.84E+00	9.53E+03	1.38E+05	2.25E+08
Saint Lucie 1	05000335	2	PWR	CE	PWR-DRYAMB	CE	2700	839	continue	completed	2.99E-05	1.53E+01	4.25E+04	5.12E+05	1.42E+09
Saint Lucie 2	05000389	2	PWR	CE	PWR-DRYAMB	CE	2700	839	continue	completed	2.99E-05	1.53E+01	4.25E+04	5.12E+05	1.42E+09
Salem 1	05000272	1	PWR	WEST	PWR-DRYAMB	WEST 4LP	3459	1174	exclude	under review	4.95E-05	7.82E+01	3.06E+05	1.58E+06	6.18E+09
Salem 2	05000311	1	PWR	WEST	PWR-DRYAMB	WEST 4LP	3459	1130	exclude	under review	4.95E-05	7.82E+01	3.06E+05	1.58E+06	6.18E+09
San Onofre 2	5000361	4	PWR	CE	PWR-DRYAMB	CE	3438	1070	not in scope						
San Onofre 3	5000362	4	PWR	CE	PWR-DRYAMB	CE	3438	1080	not in scope						
Seabrook 1	05000443	1	PWR	WEST	PWR-DRYAMB	WEST 4LP	3648	1295	continue	under review	1.44E-05	1.07E+01	2.35E+04	7.44E+05	1.63E+09
Sequoyah 1	05000327	2	PWR	WEST	PWR-ICECND	WEST 4LP	3455	1148	continue	letter of intent					
Sequoyah 2	05000328	2	PWR	WEST	PWR-ICECND	WEST 4LP	3455	1126	continue	letter of intent					
South Texas 1	05000498	4	PWR	WEST	PWR-DRYAMB	WEST 4LP	3853	1265	exclude	under review	6.24E-06	1.74E+00	1.92E+03	2.79E+05	3.08E+08
South Texas 2	05000499	4	PWR	WEST	PWR-DRYAMB	WEST 4LP	3853	1265	exclude	under review	6.24E-06	1.74E+00	1.92E+03	2.79E+05	3.08E+08
Summer	05000395	2	PWR	WEST	PWR-DRYAMB	WEST 3LP	2900	966	continue	completed	5.59E-05	9.54E-01	2.74E+03	1.71E+04	4.90E+07
Surry 1	05000280	2	PWR	WEST	PWR-DRYSUB	WEST 3LP	2546	799	exclude	completed	3.80E-05	1.80E+01	4.00E+04	4.74E+05	1.05E+09
Surry 2	05000281	2	PWR	WEST	PWR-DRYSUB	WEST 3LP	2546	799	exclude	completed	3.80E-05	1.80E+01	4.00E+04	4.74E+05	1.05E+09
Susquehanna 1	05000387	1	BWR	GE	BWR-MARK 2	GE 4	3952	1149	exclude	completed	1.97E-06	1.90E+00	1.12E+04	9.64E+05	5.66E+09
Susquehanna 2	05000388	1	BWR	GE	BWR-MARK 2	GE 4	3952	1140	exclude	completed	1.94E-06	1.86E+00	1.08E+04	9.59E+05	5.59E+09
Three Mile Island 1	05000289	1	PWR	B&W	PWR-DRYAMB	B&W LLP	2568	786	exclude	completed	2.37E-05	3.26E+01	1.12E+05	1.38E+06	4.74E+09
Turkey Point 3	05000250	2	PWR	WEST	PWR-DRYAMB	WEST 3LP	2300	693	exclude	completed	1.62E-05	1.09E+01	2.29E+04	6.72E+05	1.41E+09
Turkey Point 4	05000251	2	PWR	WEST	PWR-DRYAMB	WEST 3LP	2300	693	exclude	completed	1.62E-05	1.09E+01	2.29E+04	6.72E+05	1.41E+09

INFORMATION FROM THE REVIEW OF SAMAS

Last Update: April 18, 2011

Plant	Docket Number	NRC Region	Type	NSSS	Containment	NSSS Details	MWt	MWe	GI-199	license	internal	population	offsite		
									Safety/Risk Assessment	renewal	events CDF	dose risk	economic cost risk	p-rem per accident	offsite cost per accident
									screening	status	per year	p-rem/y	\$/y		
Vermont Yankee	05000271	1	BWR	GE	BWR-MARK 1	GE 4	1912	620	exclude	completed	5.03E-06	9.16E+00	2.10E+04	1.82E+06	4.17E+09
Vogtle 1	05000424	2	PWR	WEST	PWR-DRYAMB	WEST 4LP	3625	1109	exclude	completed	1.55E-05	2.04E+00	1.41E+03	1.32E+05	9.11E+07
Vogtle 2	05000425	2	PWR	WEST	PWR-DRYAMB	WEST 4LP	3625	1127	exclude	completed	1.55E-05	2.04E+00	1.41E+03	1.32E+05	9.11E+07
Waterford 3	05000382	4	PWR	CE	PWR-DRYAMB	COMB CE	3716	1157	exclude	letter of intent					
Watts Bar 1	05000390	2	PWR	WEST	PWR-ICECND	WEST 4LP	3459	1123	continue						
Wolf Creek 1	05000482	4	PWR	WEST	PWR-DRYAMB	WEST 4LP	3565	1166	continue	completed	2.98E-05	2.86E+00	1.97E+03	9.60E+04	6.62E+07
													count	81	78
													max	5.38E+06	2.54E+10
													95th	3.27E+06	1.15E+10
													90th	2.69E+06	9.44E+09
													80th	1.58E+06	5.42E+09
													mean	1.01E+06	3.23E+09
													median	6.72E+05	1.40E+09
													Comparison to NUREG/BR-0184		
													Plant	Table 5.4	Table 5.6
													Zion	1.95E+05	2.23E+08
													Surry	1.60E+05	2.30E+08
													Sequoyah	2.46E+05	3.19E+08
													Peach Bottom	2.00E+08	2.71E+09
													Grand Gulf	1.93E+05	1.87E+08
													Average	1.99E+05	2.46E+08
Offsite costs in NUREG/BR-0184 are in 1990 dollars															

Stutzke, Martin

From: Stutzke, Martin
Sent: Tuesday, April 26, 2011 2:48 PM
To: Ake, Jon; Burnell, Scott; Munson, Clifford
Cc: Kammerer, Annie
Subject: RE: Quick fact-check on MSNBC response

Scott -

I agree with the fixes that Cliff and Jon have suggested.

Marty

-----Original Message-----

From: Ake, Jon
Sent: Tuesday, April 26, 2011 1:49 PM
To: Burnell, Scott; Munson, Clifford; Stutzke, Martin
Cc: Kammerer, Annie
Subject: RE: Quick fact-check on MSNBC response

Scott-

I tried to make a couple of changes to this one paragraph,

In order to more accurately compare that work with the risk-based methods being used for new reactor applications, the NRC did a screening analysis (which is NOT a detailed risk analysis) to determine if there were any noticeable difference in results between the methods, which would suggest additional investigations may be warranted for existing plants. Most importantly, it included some very low probability ground motion values and highly simplified models of plant response. These factors skewed the results and make them inappropriate for use as a robust measure of current risk or any detailed ranking of relative risk.

Jon

From: Burnell, Scott
Sent: Tuesday, April 26, 2011 1:26 PM
To: Munson, Clifford; Stutzke, Martin
Cc: Ake, Jon; Kammerer, Annie
Subject: RE: Quick fact-check on MSNBC response

Take two --

From: Burnell, Scott
Sent: Tuesday, April 26, 2011 12:39 PM
To: Munson, Clifford; Stutzke, Martin
Subject: Quick fact-check on MSNBC response
Importance: High

Gentlemen;

Please review this for factual errors only – I know the language isn't at your usual level of detail. I need to know by 2 p.m. if any edits are needed. Thanks!!

YY/534

Scott

U.S. nuclear power plants are indeed designed to withstand violent ground shaking, quantified in terms of acceleration -- 'g,' the force of gravity. Detailed site analysis will identify the ground acceleration from the strongest earthquake expected to affect the site, and the reactor will be designed to withstand that "safe shutdown earthquake" with all safety systems operational. U.S. plant safe shutdown earthquakes vary from 0.1g to 0.75g. Given that wide range of design limits and the site-to-site geologic variability, it's really a non sequitur to seismically compare or rank plants.

The MSNBC.com article inappropriately drew from an NRC project we call Generic Issue 199 -- we issued a press release on interim results in September 2010: <http://pbadupws.nrc.gov/docs/ML1025/ML102510123.pdf>.

The staff started on the project in 2005 after the agency started examining updated seismic source and ground motion models provided by Early Site Permit applicants. The updated seismic information included new Electric Power Research Institute (EPRI) models to estimate earthquake ground motion and updated models for earthquake sources in seismic regions such as eastern Tennessee, and around both Charleston, S.C. and New Madrid, Mo. The staff evaluated this new information along with information from a 2004 U.S. Geological Survey letter report regarding seismic hazard estimates. The staff compared the new seismic hazard data with earlier "external event" evaluations and concluded that the seismic designs of operating plants in the Central and Eastern U.S. (CEUS) still provide adequate safety margins.

In order to most accurately compare that work with the risk-based methods being used for new reactor applications, the NRC did a screening analysis (NOT a realistic risk analysis) to determine if there were any noticeable differences between the methods, which would suggest more work is needed for existing plants. The screening used seismic hazard data and models from the USGS, seismic risk information from external event analyses and EPRI work for all CEUS nuclear power plant sites. Most importantly, it also included some highly improbably ground motion values and plant models with imprecise approximations. These factors skewed the results and made them inappropriate for considering current risk.

MSNBC.com inappropriately selected a portion of the screening analysis data (not even the screening analysis conclusions) and unilaterally declared those to be "NRC rankings." That is somewhat like taking AL East teams' spring training batting averages and saying that represents the division's final regular-season standings -- in other words, flat wrong.

The screening found that, although overall seismic risk remains low, some seismic hazard estimates have increased and warrant further attention. That attention will come in the form of an NRC Generic Letter (GL), currently under development, to request information from all U.S. nuclear plants. We expect to issue the GL by the end of 2011, near the time when NRC/DOE/EPRI-created, USGS-reviewed seismic models will become available. The NRC expects plants will provide responses to the GL in 2012 and we'll review that information to determine whether any plant improvements are needed.

Subject: BRIEFING ON THE STATUS OF NRC RESPONSE TO EVENTS IN JAPAN AND BRIEFING ON STATION BLACKOUT (Public Meeting)
Location: OWFN 1st Fl Conf Rm
Start: Thu 4/28/2011 9:30 AM
End: Thu 4/28/2011 11:30 AM
Recurrence: (none)
Meeting Status: Accepted
Organizer: CommissionCalendar Resource
Required Attendees: Apostolakis, George; Ash, Darren; Blake, Kathleen; Borchardt, Bill; Bozin, Sunny; Bubar, Patrice; Burns, Stephen; Cianci, Sandra; Commission_Hearing_Room; Crawford, Carrie; Franovich, Mike; GBJGroupCalendar Resource; GEA_Daily_Cal Resource; GEA_Staff_Daily Resource; Harves, Carolyn; Hasan, Nasreen; Hayden, Elizabeth; Herr, Linda; Jaczko, Gregory; Joosten, Sandy; Kock, Andrea; Lepre, Janet; Muesle, Mary; Nieh, Ho; Pulley, Deborah; Sharkey, Jeffry; Svinicki, Kristine; Taylor, Renee; Temp, WCO; Temp, WDM; Vietti-Cook, Annette; Virgilio, Martin; Weber, Michael

When: Thursday, April 28, 2011 9:30 AM-11:30 AM (GMT-05:00) Eastern Time (US & Canada).
Where: OWFN 1st Fl Conf Rm

Note: The GMT offset above does not reflect daylight saving time adjustments.

~~*~*~*~*~*~*~*~*

HY/535

Coe, Doug

From: Trocine, Leigh
Sent: Thursday, April 28, 2011 8:08 AM
To: Cheek, Michael; Bowman, Eric; Jones, Steve; Wertz, Trent; Nguyen, Quynh; Williams, Donna; Rosales-Cooper, Cindy; Shropshire, Alan; Layton, Michael; Wastler, Sandra; Brochman, Phil; Collins, Timothy
Cc: Correia, Richard; Coe, Doug; Gibson, Kathy; Tinkler, Charles; Schaperow, Jason; Armstrong, Kenneth; Scott, Michael; Helton, Donald; Coyne, Kevin; Bowman, Gregory; Williams, Shawn; Merzke, Daniel; Ruland, William; Lee, Samson; Ordaz, Vonna; White, Bernard; Andersen, James
Subject: STATUS -- RE: URGENT ACTION -- MAGWOOD Request for Briefing on SFP Storage Safety, Post 9/11 SFP Mitigation Measure Requirements, and SFP Safety and Security-Post 9/11 Studies

Hello All,

I asked for the Monday timeframe (05/02 from 1500 to 1630), and Commissioner Magwood's Administrative Assistant wants to check with him one more time before confirming it. I'll plan to inform you as soon as I know for sure.

Thanks a million for the prompt replies!

Cheers,
Leigh

From: Cheek, Michael
Sent: Wednesday, April 27, 2011 6:12 PM
To: Trocine, Leigh; Bowman, Eric; Jones, Steve; Wertz, Trent; Nguyen, Quynh; Williams, Donna; Shropshire, Alan; Layton, Michael; Wastler, Sandra; Brochman, Phil; Collins, Timothy
Cc: Correia, Richard; Coe, Doug; Gibson, Kathy; Tinkler, Charles; Schaperow, Jason; Armstrong, Kenneth; Scott, Michael; Helton, Donald; Coyne, Kevin; Bowman, Gregory; Williams, Shawn; Merzke, Daniel; Ruland, William; Lee, Samson; Ordaz, Vonna; White, Bernard
Subject: RE: URGENT ACTION -- MAGWOOD Request for Briefing on SFP Storage Safety, Post 9/11 SFP Mitigation Measure Requirements, and SFP Safety and Security-Post 9/11 Studies

Leigh – As will be the case for the Cmrs Apostolakis and Svinicki briefing, presentations will be made by NRR and RES staff. These presenters will be available (and prefer) Monday. Thanks

We will coordinate with NSIR, NRO and NMSS to be present in case questions come up in their areas.

Mike

From: Trocine, Leigh
Sent: Wednesday, April 27, 2011 4:51 PM
To: Cheek, Michael; Bowman, Eric; Jones, Steve; Wertz, Trent; Nguyen, Quynh; Williams, Donna; Shropshire, Alan; Layton, Michael; Wastler, Sandra; Brochman, Phil
Cc: Correia, Richard; Coe, Doug; Gibson, Kathy; Tinkler, Charles; Schaperow, Jason; Armstrong, Kenneth; Scott, Michael; Helton, Donald; Coyne, Kevin; Bowman, Gregory; Williams, Shawn; Merzke, Daniel
Subject: URGENT ACTION -- MAGWOOD Request for Briefing on SFP Storage Safety, Post 9/11 SFP Mitigation Measure Requirements, and SFP Safety and Security-Post 9/11 Studies
Importance: High

Hello all,

44/536

Commissioner Magwood heard about the 04/29 briefing Commissioners Svinicki and Apostolakis on SFP Storage Safety, Post 9/11 SFP Mitigation Measure Requirements, and SFP Safety and Security-Post 9/11 Studies; and he would like the same briefing on either Monday (05/02) or Tuesday (05/03). Commissioner Magwood is currently available at the following times:

- Monday (05/02) from 1500 to 1630
- Tuesday (05/03) from 1430 to 1600

I've heard that the RES presenters (either Charlie Tinkler or Jason Schaperow) can support either time. (Please let me know if my understanding is incorrect.) I've also heard that NRR, NRO, and/or NSIR have either presenters or supporters.

ACTION – Please confirm whether the NRR, NRO, and/or NSIR presenters for the 04/29 briefing (or actors) can support the same briefing for Commissioner Magwood on 05/02 or 05/03. It would also be helpful to know whether there is a preference in either of those two dates.

Please feel free to pass this request along if I've missed anyone!

Sorry for the short-term request! Thanks in advance for your help!

Cheers,
Leigh

From: IRfeedback resource
Sent: Thursday, April 28, 2011 8:25 AM
To: Borchardt, Bill; Abrams, Charlotte; Abu-Eid, Boby; Adams, John; Afshar-Tous, Mugeh; Alemu, Bezakulu; Algama, Don; Algama, Don; Alter, Peter; Alter, Peter; Anderson, James; Arndt, Steven; Ashkeboussi, Nima; Bailey, Marissa; Ballam, Nick; Ballam, Nick; Barr, Cynthia; Barss, Dan; Beasley, Benjamin; Bergman, Thomas; Berry, Rollie; Berry, Rollie; Bhachu, Ujagar; Billings, Sally; Billings, Sally; Bloom, Steven; Bloom, Steven; Blount, Tom; Blount, Tom; Boger, Bruce; Bowers, Anthony; Bowers, Anthony; Bowman, Gregory; Boyce, Tom (RES); Brandon, Lou; Brandon, Lou; Brandt, Philip; Brock, Kathryn; Brown, David; Brown, Frederick; Brown, Eva; Brown, Eva; Brown, Michael; Brown, Cris; Bukharin, Oleg; Burkhalter, Cornelia; Bush-Goddard, Stephanie; Caldwell, Robert; Campbell, Steve; Campbell, Andy; Camper, Larry; Carpenter, Cynthia; Caruso, Mark; Case, Michael; Casto, Greg; Casto, Greg; Cecere, Bethany; Cervera, Margaret; Chakrabarti, Samir; Chakravorty, Manas; Chazell, Russell; Chen, Yen-Ju; Cheng, May; Cheok, Michael; Chokshi, Nilesh; Chowdhury, Prosanta; Chowdhury, Prosanta; Chung, Donald; Kowalczyk, Jeffrey; Circle, Jeff; Clement, Richard; Clinton, Rebecca; Coe, Doug; Collins, Frank; Collins, Frank; Cool, Donald; Correia, Richard; Corson, James; Costa, Arlon; Craffey, Ryan; Cranston, Gregory; Criscione, Lawrence; Crutchley, Mary Glenn; Crutchley, Mary Glenn; Cruz, Zahira; Dacus, Eugene; DeCicco, Joseph; DeCicco, Joseph; Decker, David; Dembek, Stephen; Dempsey, Jeanne; Devlin, Stephanie; Devlin, Stephanie; Doane, Margaret; Dorman, Dan; Dorman, Dan; Dorsey, Cynthia; Dorsey, Cynthia; Dorsey, Cynthia; Dorsey, Cynthia; Dozier, Jerry; Droggitis, Spiros; Dube, Donald; Dudes, Laura; Dyer, Jim; Eads, Johnny; Easson, Stuart; Emche, Danielle; English, Lance; Erlanger, Craig; Esmaili, Hossein; Evans, Michele; Faria-Ocasio, Carolyn; Fehst, Geraldine; Figueroa, Roberto; Fiske, Jonathan; Fiske, Jonathan; Fiske, Jonathan; Flannery, Cindy; Foggie, Kirk; Foster, Jack; Fragoyannis, Nancy; Franovich, Rani; Frazier, Alan; Fuller, Edward; Galletti, Greg; Gambone, Kimberly; Gardocki, Stanley; Gavrilas, Mirela; Ghosh, Tina; Gibson, Kathy; Giitter, Joseph; Gilmer, James; Glenn, Nichole; Gordon, Dennis; Gott, William; Grant, Jeffery; Grant, Jeffery; Gray, Anita; Greenwood, Carol; Grimes, Kelly; Grimes, Kelly; Grobe, Jack; Gross, Allen; Hackett, Edwin; Hale, Jerry; Hardesty, Duane; Hardin, Kimberly; Hardin, Leroy; Hardin, Leroy; Harris, Tim; Harris, Brian; Harrison, Donnie; Hart, Michelle; Hart, Ken; Hart, Michelle; Harvey, Brad; Hasselberg, Rick; Helton, Donald; Henderson, Karen; Hiland, Patrick; Holahan, Patricia; Holahan, Vincent; Holahan, Patricia; Holahan, Vincent; Holian, Brian; Holonich, Joseph; Holonich, Joseph; Horn, Brian; Howard, Tabitha; Howard, Tabitha; Howe, Allen; Howe, Andrew; Howe, Allen; Hudson, Nathanael; Huffert, Anthony; Hurd, Sapna; Huyck, Doug; Imboden, Andy; Isom, James; Iyengar, Raj; Jackson, Karen; Jervey, Richard; Jervey, Richard; Jessie, Janelle; Johnson, Michael; Johnson, Don; Jolicoeur, John; Jones, Cynthia; Jones, Andrea; Kahler, Carolyn; Kammerer, Annie; Karas, Rebecca; Kauffman, John; Kavanagh, Kerri; Khan, Omar; Kokajko, Lawrence; Kolb, Timothy; Koshy, Thomas; Kotzalas, Margie; Kotzalas, Margie; Kotzalas, Margie; Kowalczyk, Jeffrey; Kozal, Jason; Kratchman, Jessica; Kratchman, Jessica; Kugler, Andrew; Lamb, Christopher; Larson, Emily; Larson, Emily; Laur, Steven; LaVera, Ronald; LaVie, Steve; Layton, Michael; Layton, Michael; Leeds, Eric; Lewis, Robert; Lewis, Doris; Li, Yong; Lichatz, Taylor; Lichatz, Taylor; Lising, Jason; Lombard, Mark; Lovell, Louise; Lubinski, John; Lubinski, John; Lui, Christiana; Lukes, Kim; Lynch, Jeffery; Mamish, Nader; Manahan, Michelle; Manahan, Michelle; Marksberry, Don; Marshall, Jane; Maupin, Cardelia; Mayros, Lauren; Mazaika, Michael; McCoppin, Michael; McDermott, Brian; McGinty, Tim; McGinty, Tim; McGovern, Denise; Magruder, Stewart; McMurtray, Anthony; Merritt, Christina; Meyer, Karen; Miller, Chris; Miller, Charles; Milligan, Patricia; Milligan, Patricia; Milligan, Patricia; Mitman, Jeffrey; Mohseni, Aby; Moore, Scott; MorganButler, Kimyata; Morlang, Gary; Morris, Scott; Mroz (Sahm), Sara; Mroz (Sahm), Sara; Munson, Clifford; Murray, Charles; Musico, Bruce; Nerret, Amanda; Nguyen, Caroline; Nibert, Patty; Noonan, Amanda; Norris, Michael; Norris, Michael; Norton, Charles; Nosek, Andrew; Opara, Stella; Opara, Stella; Ordaz, Vonna; Orr, Mark; Owens, Janice; Padovan, Mark; Parillo, John; Parillo, John; Patel, Pravin; Patel, Jay; Perin, Vanice; Perin, Vanice; Phan, Hanh; Pope, Tia; Pope, Tia; Powell, Amy; Purdy, Gary; Quinlan, Kevin; Ragland, Robert; Ragland, Robert; Ragland, Robert; Ralph, Melissa; Ralph, Melissa; Ralph, Melissa; Ramadan, Liliana; Ramsey, Jack; Reed, Wendy; Reed, Elizabeth; Reeves, Rosemary; Reis, Terrence; Resner, Mark; Rheame, Cynthia; Richards, Stuart; Riley (OCA), Timothy; Riner, Kelly; Riner, Kelly; Rini, Brett; Rivera, Alison; Rivers, Joseph; Roach, Edward; Robinson, Edward; Robinson, Edward; Rodriguez-Luccioni, Hector; Roggenbrodt, William; Gambone, Kimberly; Rosales-Cooper, Cindy; Rosenberg, Stacey; Ross-Lee, MaryJane; Roundtree, Amy; Rowe, T; Rowe, T; Ruland,

To: William; Russell, Tonya; Russell, Tonya; Russell, Tonya; Russell, Tonya; Ryan, Michelle; Saba, Mohammad; Salay, Michael; Salter, Susan; Salus, Amy; Salus, Amy; Sanfilippo, Nathan; Scarbrough, Thomas; Schaperow, Jason; Schmidt, Rebecca; Schmidt, Duane; Schmidt, Duane; Schneider, Stewart; Schoenebeck, Greg; Schrader, Eric; Schrader, Eric; Schrader, Eric; Schwartzman, Jennifer; Seber, Dogan; Seber, Dogan; See, Kenneth; Shane, Raeann; Shea, James; Shepherd, Jill; Sheron, Brian; Skarda, Raymond; Skeen, David; Sloan, Scott; Sloan, Scott; Smiroldo, Elizabeth; Smith, Stacy; Smith, Theodore; Smith, Brooke; Solorio, Dave; Stahl, Eric; Stang, Annette; Stang, Annette; Starefos, Joelle; Steger (Tucci), Christine; Steger (Tucci), Christine; Stieve, Alice; Stone, Rebecca; Stone, Rebecca; Stone, Rebecca; Stransky, Robert; Sturz, Fritz; Sturz, Fritz; Sullivan, Randy; Sullivan, Randy; Sullivan, Randy; Summers, Robert; Sun, Casper; Sun, Casper; Susco, Jeremy; Takacs, Michael; Tappert, John; Tappert, John; Tegeler, Bret; Temple, Jeffrey; Temple, Jeffrey; Thaggard, Mark; Thaggard, Mark; Thomas, Eric; Thompson, John; Thorp, John; Tiruneh, Nebiyu; Tobin, Jennifer; Tomon, John; Tracy, Glenn; Trefethen, Jean; Tschiltz, Michael; Turtill, Richard; Uhle, Jennifer; Uhle, Jennifer; Valencia, Sandra; Valencia, Sandra; Vaughn, James; Velazquez-Lozada, Alexander; Vick, Lawrence; Virgilio, Martin; Virgilio, Rosetta; Willis, Dori; Ward, Leonard; Wastler, Sandra; Watson, Bruce; Webber, Robert; Weber, Michael; Wheeler, Larry; White, Bernard; Wiggins, Jim; Williams, Kevin; Williams, Donna; Williams, Joseph; Williamson, Linda; Wimbush, Andrea; Wimbush, Andrea; Wimbush, Andrea; Wittick, Brian; Wong, See-Meng; Wray, John; Wright, Lisa (Gibney); Wright, Lisa (Gibney); Wright, Ned; Wunder, George; Young, Francis; Zimmerman, Roy; Zimmerman, Jacob; Zimmerman, Jacob; Zoulis, Antonios

Subject: REQUEST: Japan Event Feedback
Attachments: NRC Japan IR AAR Input Form.docx

Dear colleagues,

Attached you will find a Feedback Form regarding the NRC's incident response efforts to the Japan crisis. Realizing the response is still on-going, the Division of Preparedness and Response would like to continue the ongoing efforts of collecting feedback and information from incident responders to start developing an After Action Report (AAR). The Feedback Form can be returned to the IRFeedback.resource@nrc.gov mailbox (reply to this email). Your submissions may be submitted in an anonymous fashion if you choose, and all comments and feedback will be non-attributional.

We will also be scheduling multiple Hot Washes for teams involved in the response efforts. These Hot Washes will be conducted in May, on a team by team basis. Invitations to these events will be distributed next week. The Hot Washes will be another chance for teams and responders to discuss the response efforts and provide information to include in the AAR.

Your input and participation is valuable in developing an AAR that effectively analyzes NRC response efforts, and identifies strengths and areas needing improvement. If you have any questions concerning the AAR process, please contact Jason Kozal at 301-415-6231, or Sally Billings at 301-415-6412. Please return these forms no later than COB May 30th.

Respectfully,

Scott A. Morris
Deputy Director for Incident Response
Office of Nuclear Security & Incident Response

**U.S. Nuclear Regulatory Commission
Japan Incident Response**

AFTER ACTION REPORT INPUT FORM

Point of Contact Information: _____

Name: _____ Office: _____

Phone #: _____ E-mail: _____

Position Filled During Response: _____

Characterization: Strength Area for Improvement N/A

Observation: (Specific description of issue)

Analysis - Why is this an issue?: (Identify root cause of the issue; e.g., plans, training, equipment, etc.)

Recommendation(s):

Coe, Doug

From: Weerakkody, Sunil
Sent: Friday, April 29, 2011 10:25 AM
To: Coe, Doug; Coyne, Kevin; Helton, Donald; Wong, See-Meng; Correia, Richard; Case, Michael
Cc: Cheok, Michael; Lee, Samson
Subject: RE: request for urgent help

Doug\Kevin,

We are meeting with Don Helton around 11.30 AM today. If Kevin can call in 301-415-2884 to Mike's office, that would be great (not essential). The due date on us was updated from Monday COB to Sunday COB. As such, our strategy is to benefit from any information that Don could provide us during that meeting (or any information that Don could send us via Email shortly after) and perform an analysis whose quality will be constrained by the dictated due date. See-Meng is cognizant of the need to clearly articulate assumptions\boundary conditions etc.. so that the recipients understand the context of the analysis.

We do not expect to rely on Don's help over the weekend. If we do, then, I will get back to you using the protocol that RES has established. Thanks to Kevin and Don for offering to support us on short notice.

Sunil Weerakkody
Branch Chief
DRA\APOB (Acting)

From: Coe, Doug
Sent: Friday, April 29, 2011 9:51 AM
To: Weerakkody, Sunil; Coyne, Kevin; Helton, Donald; Wong, See-Meng; Correia, Richard; Case, Michael
Subject: FW: request for urgent help

Sunil,
FYI - These short-term taskers from IRC are supposed to go through our RES poc (Mike Case, Kathy Gibson, Richard Lee in that order). I've cc'd Mike Case.

I recommend that we set up a telecon with IRC, NRR, and RES for today. Purpose will be for those parties to understand the intent of this tasking and to determine what resources will be needed over the weekend.

From: Coyne, Kevin
Sent: Friday, April 29, 2011 9:23 AM
To: Weerakkody, Sunil
Cc: Helton, Donald; Wong, See-Meng; Coe, Doug; Correia, Richard
Subject: RE: request for urgent help

Sunil –

Let's not get too far ahead on this. Don can support a brief meeting with you and See-Meng to provide some general insights, but we need to make sure we stay within our work control processes and keep our respective management teams informed - particularly if we are talking about overtime over the weekend (which I think would be hard to justify unless there truly a significant need for this information by Monday – not to mention that I'm not even sure that Don or other knowledgeable RES staff are even available to work on this over the weekend...). I think a key thing is to better define the intended purpose of the assessment and what specific support is needed from RES. I'm not sure that much can be done in a day or two to better define the picture beyond what has already been done by other studies (e.g., NUREG-1738). If we can put some boundaries

44/538

around this task such as a risk assessment of water makeup system or SFP cooling systems, we are more likely to be on a success path.

-Kevin

From: Weerakkody, Sunil
Sent: Friday, April 29, 2011 8:44 AM
To: Coyne, Kevin
Cc: Helton, Donald; Wong, See-Meng
Subject: request for urgent help

Kevin,

After I left a message with, I contacted Don. He agreed to meet with See-Meng at 11.30 AM today at HQ. So we are set for now. In the event Don has to work OT over the weekend (this is due on 5/2 and we got the assignment yesterday), can you\Don help?

Sunil

Coe, Doug

From: Trocine, Leigh
Sent: Friday, April 29, 2011 10:55 AM
To: Cheok, Michael; Bowman, Eric; Jones, Steve; Wertz, Trent; Nguyen, Quynh; Williams, Donna; Rosales-Cooper, Cindy; Shropshire, Alan; Layton, Michael; Wastler, Sandra; Brochman, Phil; Collins, Timothy; Correia, Richard; Coe, Doug; Gibson, Kathy; Tinkler, Charles; Schaperow, Jason; Armstrong, Kenneth; Scott, Michael; Helton, Donald; Coyne, Kevin; Ruland, William; Lee, Samuel; Ordaz, Vonna; White, Bernard; Benner, Eric; Weaver, Doug
Cc: Bowman, Gregory; Williams, Shawn; Merzke, Daniel; Frazier, Alan; Andersen, James
Subject: HEADS UP/ACTION -- 1500-1630 05/02 -- RES/NRR/NRO/NSIR/NMSS Briefing for MAGWOOD on SFP Storage Safety, Post 9/11 SFP Mitigation Measure Requirements, and SFP Safety and Security-Post 9/11 Studies
Attachments: Staff Briefing on Security of Spent Fuel Pools
Importance: High

Hello All,

HEADS UP: I received a heads up from Commissioner Magwood's TA that, in addition to the subject above, he is interested in the **issues associated with putting hotter fuel into ISFSIs**. They are aware that it is short notice to prepare some slides on this. If we can great. It's okay if not. At a minimum, Commissioner Magwood would like to have the right folks in attendance to **be able to discuss the issue**.

ACTION: As I mentioned yesterday, we're scheduled for 05/02 from 1500 to 1630 in the 2nd Floor SKIF (scheduler attached). Commissioner Magwood's office has requested a **list of the presenters and contributors/supporters**. I took a shot at one below. **Please confirm for your name, level of participation, and office as well as other that you might know.**

PROPOSE LIST OF PRESENTERS

RES

Charlie Tinkler
Jason Schaperow

NRR

Steve Jones
Eric Bowman

PROPOSE LIST OF CONTRIBUTORS/UPPORT FOR POSSIBLE QUESTIONS

RES

Don Helton
Ken Armstrong
Kathy Gibson
Mike Scott
Kevin Coyne

NRR

Mike Cheok

NRO

Samuel Lee -- B5b and New Reactors
Mark Caruso -- B5b and New Reactors

YY/539

NSIR

Sandra Wastler
Phil Brochman
Mike Layton

NMSS

Eric Benner
Doug Weaver
Vonna Ordaz
Bernard White

Thanks again for your help!

Cheers,
Leigh

From: Trocine, Leigh

Sent: Thursday, April 28, 2011 6:50 PM

To: Cheok, Michael; Bowman, Eric; Jones, Steve; Wertz, Trent; Nguyen, Quynh; Williams, Donna; Rosales-Cooper, Cindy; Shropshire, Alan; Layton, Michael; Wastler, Sandra; Brochman, Phil; Collins, Timothy; Correia, Richard; Coe, Doug; Gibson, Kathy; Tinkler, Charles; Schaperow, Jason; Armstrong, Kenneth; Scott, Michael; Helton, Donald; Coyne, Kevin; Ruland, William; Lee, Samson; Ordaz, Vonna; White, Bernard; Benner, Eric; Weaver, Doug

Cc: Bowman, Gregory; Williams, Shawn; Merzke, Daniel; Frazier, Alan; Andersen, James

Subject: ACTION -- 1500-1640 05/02 -- RES/NRR/NRO/NSIR/NMSS Briefing for MAGWOOD on SFP Storage Safety, Post 9/11 SFP Mitigation Measure Requirements, and SFP Safety and Security-Post 9/11 Studies

Hello All,

Commissioner Magwood has confirmed the date/time for the subject briefing as 05/02 from 1500 to 1630 in the 2nd Floor SKIF (scheduler attached). Please provide me with the final list of names of the presenters so that I can forward them to Commissioner Magwood's Administrative Assistant (as requested). Thanks in advance for your help!

Cheers,
Leigh

Coe, Doug

From: Correia, Richard
Sent: Saturday, April 30, 2011 3:36 PM
To: Skeen, David; Marksberry, Don; Tracy, Glenn
Cc: Coe, Doug; Demoss, Gary; Lee, Richard; Jackson, Karen; Hogan, Rosemary
Subject: RE: Question from NISA on reporting to the IAEA

Thanks Dave. I fully support your recommendations.

thank you Don for responding so quickly and thoroughly!

rich

Rich Correia, PE
Director
Division of Risk Analysis
RES
US NRC

From: Skeen, David
Sent: Saturday, April 30, 2011 3:29 PM
To: Correia, Richard; Marksberry, Don; Tracy, Glenn
Cc: Coe, Doug; Demoss, Gary; Lee, Richard; Jackson, Karen; Hogan, Rosemary
Subject: RE: Question from NISA on reporting to the IAEA

I agree we shouldn't just pass along Don's notes as written below.

I will assign a tasker to the LT to provide a final response by Wednesday evening. On Monday, the LT could work with Don and glean the essential information from Don's notes to pass along to Steve Reynolds whatever we know as interim information. They can also reach out to IAEA via OIP.

From: Correia, Richard
Sent: Saturday, April 30, 2011 3:16 PM
To: Marksberry, Don; Skeen, David; Tracy, Glenn
Cc: Coe, Doug; Demoss, Gary; Lee, Richard; Jackson, Karen; Hogan, Rosemary
Subject: Re: Question from NISA on reporting to the IAEA

Thanks Don. This information is very useful.

Dave. Glenn. I would propose to have OIP reach out to IAEA and ask them what historical information that have relative to TMI. It may be faster than searching around NRC for someone that might have different information than what Don has found thus far. I would also recommend we send Steve Reynolds what Don has provided here only as "this is what we know to date but we are continuing to search for more information". Steve can advise NISA as he feels is prudent but I would be careful not to give NISA Don's notes as written.

Thoughts?
Rich

Rich
Richard Correia, Director
Division of Risk Analysis

YY/540

RES

Sent from a Blackberry

From: Marksberry, Don
To: Correia, Richard
Cc: Coe, Doug; Demoss, Gary; Skeen, David; Lee, Richard; Jackson, Karen; Hogan, Rosemary
Sent: Sat Apr 30 10:01:02 2011
Subject: RE: Question from NISA on reporting to the IAEA Rich

I don't remember that IAEA was into incident notification and response until post Chernobyl. After TMI-2, an IAEA expert group was formed and establishes international guidelines on emergency planning and response. After Chernobyl, the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of Nuclear Accident or Radiological Emergency were established.

Neither the Kemeny Commission nor the Rogovin reports mention "IAEA" or "international," except for the routine (annual) exchange of operating experience information via IAEA and the international media response to the accident. (Kemeny Commission - Report Of The Public's Right To Information Task Force quoted: "Instead of a regional story, TMI quickly became a national and international story which attracted a worldwide press corps numbering at any one time from 300 to 500 journalists, including reporters from Japan, France, Sweden, West Germany, Italy, Spain, and Great Britain.") In addition, none of the NRC investigations and actions NUREGs (e.g., 0578, 0585, 0600, 0616, 0660, 0737) mentioned IAEA or international.

Ops Center transcripts for the first 6 days of Executive Management Team meetings (Commission meetings were recorded in the Ops Center and H-Street) did not mention IAEA or international.

Daily Preliminary Notifications (PNs) were issued (see attached), but I'm not sure about the distribution (I've never seen any NRC press releases). I believe that International programs was part of state programs at the time.

The two people who may remember what happened in the Op Center during TMI-2 are Karen Jackson (NSIR) and Tom McKenna (retired NRC, IAEA response manager--- Tom was mentioned in a recent e-mail from IAEA working on a RASCAL run). Rosemary Hogan was the liaison team coordinator for awhile following Chernobyl. Bob Senseney (retired a few months ago from the DOS) was the OIP guy during TMI and Chernobyl.

Don

(I also found one of the early public statements of core melt at TMI-2---seven year later).

From: Correia, Richard
Sent: Saturday, April 30, 2011 7:35 AM
To: Marksberry, Don; Demoss, Gary; Coe, Doug
Cc: Skeen, David
Subject: Fw: Question from NISA on reporting to the IAEA

Don. Can you assist with the Nisa questions below? Don't start answering them but just let me know if you feel you have the information to answer it or you know who would have the information. We'll decide who will answer after that. Many thanks. Rich Richard Correia, Director Division of Risk Analysis RES

Sent from a Blackberry

From: Reynolds, Steven - R - III

To: RST01 Hoc; LIA08 Hoc; LIA07 Hoc

Cc: Casto, Chuck; Mitchell, Matthew; Young, Francis; Skeen, David; Tracy, Glenn; Correia, Richard

Sent: Fri Apr 29 22:05:12 2011

Subject: Question from NISA on reporting to the IAEA We received the following question from NISA.

After the TMI accident, what was reported to the IAEA about the accident, who reported it (e.g., NRC, TMI operator, other US government agency), when was it reported (how long after the accident), and how was it reported?

Can you have someone get back to us with the answer?

Thanks,

Steve

Coe, Doug

From: Skeen, David
Sent: Saturday, April 30, 2011 3:42 PM
To: LIA08 Hoc; LIA07 Hoc; OST01 HOC
Cc: Casto, Chuck; Mitchell, Matthew; Young, Francis; Tracy, Glenn; Correia, Richard; Reynolds, Steven; RST01 Hoc; Marksberry, Don
Subject: RE: Question from NISA on reporting to the IAEA

Liaison Team,

Please create a task assigned to the LT, to provide the TMI information requested by NISA to the Site Team by Wednesday evening (5/4/11). Don Marksberry, in RES, is a good point of contact on this issue. In addition, you may want to ask OIP to contact IAEA to see if they can help pull together information on who/when/how the US reported the TMI accident.

Don Marksberry has some preliminary information that could be provided to Steve Reynolds and the site team by Monday evening, and then a final response could be provided to the Site Team on Wednesday evening.

Thanks!

From: Reynolds, Steven
Sent: Friday, April 29, 2011 10:05 PM
To: RST01 Hoc; LIA08 Hoc; LIA07 Hoc
Cc: Casto, Chuck; Mitchell, Matthew; Young, Francis; Skeen, David; Tracy, Glenn; Correia, Richard
Subject: Question from NISA on reporting to the IAEA

We received the following question from NISA.

After the TMI accident, what was reported to the IAEA about the accident, who reported it (e.g., NRC, TMI operator, other US government agency), when was it reported (how long after the accident), and how was it reported?

Can you have someone get back to us with the answer?

Thanks,
Steve

44/541

Coe, Doug

From: Marksberry, Don
Sent: Saturday, April 30, 2011 10:01 AM
To: Correia, Richard
Cc: Coe, Doug; Demoss, Gary; Skeen, David; Lee, Richard; Jackson, Karen; Hogan, Rosemary
Subject: RE: Question from NISA on reporting to the IAEA
Attachments: NRC Preliminary Notifications - TMI-2 (3-28 to 5-29-1979).pdf, TMI Cleanup (AP Wire 03-12-1986).pdf

Rich

I don't remember that IAEA was into incident notification and response until post Chernobyl. After TMI-2, an IAEA expert group was formed and establishes international guidelines on emergency planning and response. After Chernobyl, the Convention on Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of Nuclear Accident or Radiological Emergency were established.

Neither the Kemeny Commission nor the Rogovin reports mention "IAEA" or "international," except for the routine (annual) exchange of operating experience information via IAEA and the international media response to the accident. (Kemeny Commission - Report Of The Public's Right To Information Task Force quoted: "Instead of a regional story, TMI quickly became a national and international story which attracted a worldwide press corps numbering at any one time from 300 to 500 journalists, including reporters from Japan, France, Sweden, West Germany, Italy, Spain, and Great Britain.") In addition, none of the NRC investigations and actions NUREGs (e.g., 0578, 0585, 0600, 0616, 0660, 0737) mentioned IAEA or international.

Ops Center transcripts for the first 6 days of Executive Management Team meetings (Commission meetings were recorded in the Ops Center and H-Street) did not mention IAEA or international.

Daily Preliminary Notifications (PNs) were issued (see attached), but I'm not sure about the distribution (I've never seen any NRC press releases). I believe that International programs was part of state programs at the time.

The two people who may remember what happened in the Op Center during TMI-2 are Karen Jackson (NSIR) and Tom McKenna (retired NRC, IAEA response manager--- Tom was mentioned in a recent e-mail from IAEA working on a RASCAL run). Rosemary Hogan was the liaison team coordinator for awhile following Chernobyl. Bob Senseney (retired a few months ago from the DOS) was the OIP guy during TMI and Chernobyl.

Don

(I also found one of the early public statements of core melt at TMI-2---seven year later).

From: Correia, Richard
Sent: Saturday, April 30, 2011 7:35 AM
To: Marksberry, Don; Demoss, Gary; Coe, Doug
Cc: Skeen, David
Subject: Fw: Question from NISA on reporting to the IAEA

Don. Can you assist with the Nisa questions below? Don't start answering them but just let me know if you feel you have the information to answer it or you know who would have the information. We'll decide who will answer after that. Many thanks. Rich
Richard Correia, Director
Division of Risk Analysis
RES

441542

Sent from a Blackberry

From: Reynolds, Steven

To: RST01 Hoc; LIA08 Hoc; LIA07 Hoc

Cc: Casto, Chuck; Mitchell, Matthew; Young, Francis; Skeen, David; Tracy, Glenn; Correia, Richard

Sent: Fri Apr 29 22:05:12 2011

Subject: Question from NISA on reporting to the IAEA

We received the following question from NISA.

After the TMI accident, what was reported to the IAEA about the accident, who reported it (e.g., NRC, TMI operator, other US government agency), when was it reported (how long after the accident), and how was it reported?

Can you have someone get back to us with the answer?

Thanks,
Steve

PRELIMINARY NOTIFICATION

March 28, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67

This preliminary notification constitutes EARLY notice of event of POSSIBLE safety or public interest significance. The information presented is as initially received without verification or evaluation and is basically all that is known by IE staff on this date.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania
(Docket No. 50-320)

Subject: REACTOR SCRAM FOLLOWED BY A SAFETY INJECTION AT THREE MILE ISLAND - UNIT 2

The licensee notified Region I at approximately 7:45 AM of an incident at Three Mile Island Unit 2 (TMI-2) which occurred at approximately 4:00 AM at 98% power when the secondary feed pumps tripped due to a feedwater polishing system problem. This resulted in a turbine trip and subsequent reactor trip on High Reactor Coolant Pressure. A combination of Feed Pump Operation and Pressurizer Relief - Steam Generator relief valve operation caused a Reactor Coolant System (RCS) cooldown. At 1600 psig, Emergency Safeguards Actuation occurred. All ECCS components started and operated properly. Water level increased in the Pressurizer and Safety Injection was secured manually approximately 5 minutes after actuation. It was subsequently resumed. The Reactor Coolant Pumps were secured when low net positive suction head limits were approached.

About 7:00 AM, high activity was noted in the RCS Coolant Sample Lines (approximately 600 mr/hr contact readings). A Site Emergency was then declared. At approximately 7:30 AM, a General Emergency was declared based on High Radiation levels in the Reactor Building. At 8:30 AM site boundary radiation levels were reported to not be significant (less than 1 mr/hr). The source of activity was stated to be failed fuel as a result of the transient, and due to a known previous primary to secondary leak in Steam Generator B.

The Region I Incident Response Center was activated at 8:10 AM and direct communications with the licensee and IE:Headquarters was established. The Response Team was dispatched at 8:45 AM and arrived at the site at 10:05 AM.

At 10:45 AM the Reactor Coolant System Pressure was being held at 1950 psig with temperature at 220°F in the cold leg. By 10:45 AM, radiation levels of 3 mr/hr had been detected 500 yards offsite.

CONTINUED

There is significant media interest at the present time because of concern about potential offsite radiation/contamination. The Commonwealth of Pennsylvania and EPA have been informed. Press contacts are being made by the licensee and NRC.

Contact: GKlingler, IE x28019 FNolan, IE x28019 SEBryan, IE x28019

Distribution: Transmitted H St ^{3:45}~~3:35~~
Chairman Hendrie Commissioner Bradford S. J. Chilk, SECY
Commissioner Kennedy Commissioner Ahearne C. C. Kammerer, CA
Commissioner Gilinsky (For Distribution)

Transmitted: MNBB 3:50 P. Bldg 3:40 J. G. Davis, IE
L. V. Gossick, EDO H. R. Denton, NRR Region I 3:58
H. L. Ornstein, EDO R. C. DeYoung, NRR
J. J. Fouchard, PA R. J. Mattson, NRR
N. M. Haller, MPA V. Stello, NRR (MAIL)
R. G. Ryan, OSP R. S. Boyd, NRR J. J. Cummings, OIA
H. K. Shapar, ELD SS Bldg 3:52 R. Minogue, SD
W. J. Dircks, NMSS

PRELIMINARY NOTIFICATION

Feb

PRELIMINARY NOTIFICATION

March 29, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67A

This preliminary notification constitutes EARLY notice of event of POSSIBLE safety or public interest significance. The information presented is as initially received without verification or evaluation and is basically all that is known by IE staff on this date.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND - UNIT 2

This supplements PNO-79-67 dated March 28, 1979.

As of 3:30 p.m., on March 28, 1979, the plant was being slowly cooled down with Reactor Coolant System (RCS) pressure at 450 psi, using normal letdown and makeup flow paths. The bubble has been collapsed in the A Reactor Coolant Loop hot leg, and some natural circulation cooling has been established. Pressurizer level has been decreased to the high range of visible indication, and some heaters are in operation. The secondary plant was being aligned to draw a vacuum in the main condenser and use the A Steam Generator for heat removal. The facility plans to continue a slow (30F/hr) cooldown, until the Decay Heat Removal System can be placed in operation at 350 psi RCS pressure, 350°F RCS temperature in 15-18 hours.

As of 3:30 p.m., a plume approximately ½ mile wide and reading generally 1 m/hr was moving to the north of the plant. The ARM's helicopter is being used to define the length of the plume. Airborne iodine levels of up to 1×10^{-8} uCi/ml have been detected in Middletown, Pennsylvania, which is located north of the site.

Media interest is continuing. The Commonwealth of Pennsylvania is being kept informed by plant personnel.

Contact: GKlingler, IE x28019 FNolan, IE x28019 SEBryan, IE x28019

Distribution: Transmitted H St *NOV 23 10:30*
Chairman Hendrie
Commissioner Kennedy
Commissioner Gilinsky

Commissioner Bradford
Commissioner Ahearne

S. J. Chilk, SECY
C. C. Kammerer, CA
(For Distribution)

Transmitted: MNBB *10:25*
L. V. Gossick, EDO
H. L. Ornstein, EDO
J. J. Fouchard, PA
N. M. Haller, MPA
R. G. Ryan, OSP
H. K. Shapar, ELD

P. Bldg *10:32*
H. R. Denton, NRR
R. C. DeYoung, NRR
R. J. Mattson, NRR
V. Stello, NRR
R. S. Boyd, NRR
SS Bldg *10:28*
W. J. Dircks, NMSS

J. G. Davis, IE
Region *I* *10:33*

(MAIL)
J. J. Cummings, OIA
R. Minogue, SD

PRELIMINARY NOTIFICATION

PRELIMINARY NOTIFICATION

March 30, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67B

This preliminary notification constitutes EARLY notice of event of POSSIBLE safety or public interest significance. The information presented is as initially received without verification or evaluation and is basically all that is known by IE staff on this date.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: Nuclear Incident at Three Mile Island

Plant Status

Three Mile Island Unit 2 is continuing to remove decay heat through A-loop steam generator using one reactor coolant pump in that loop for coolant circulation. The reactor coolant pressure and temperature were stable and under control throughout the night of March 29. There has been some difficulty in maintaining coolant letdown flow due to resistance in the purification filters. The licensee notified IE at about 11:00 p.m. on March 29 that they expected to remain in this cooling mode for at least 24 hours.

The licensee's engineering staff was requested by NRR to obtain a better estimate of the volume of the noncondensable "bubbles" in the reactor coolant system. There are apparently two such bubbles one in the pressurizer that has been intentionally established for control of pressure and level, and one in the reactor vessel head caused by the accumulation of noncondensable gases from failed fuel and radiolytic decomposition of water. The estimate is to be obtained by correlating pressurizer pressure and level indications over the past hours of stable operation. The volume of the bubble in the reactor vessel is of interest in assuring that sufficient volume remains in the upper head for collection of more noncondensable gases arising from continued operation in the present cooling mode as well as to assess the potential for movement of the bubble during a switchover to decay heat removal operation.

The licensee believes it is prudent to remain in the present cooling mode due to the potential for leakage of highly radioactive coolant from the decay heat removal system into the auxiliary building, movement of noncondensable gases into the reactor coolant loop, and boiling in the core when the reactor coolant pump is shut down.

CONTINUED

Fuel Damage

Preliminary assessment of the extent of fuel damage from a reactor coolant sample taken at approximately 5:00 p.m. on March 29 indicates significant releases of iodine and noble gases from the fuel. A 100 milliliter sample taken from the primary coolant system via a letdown line was measured at about 1,000 R/hr on contact (70-80 R/hr at one foot and 10-30 R/hr at three feet). Preliminary analysis of a diluted sample in the IE mobile laboratory indicated fission product concentrations of about 8×10^5 microcuries per milliliter. The sample will be flown to Bettis Laboratory for further analysis.

Thermocouple readings of coolant temperature at the outlet of the instrumented fuel assemblies indicate potential local core damage, possibly in one quarter of the total of 177 fuel assemblies and generally in the center of the core. Of the 52 readings at 5:00 a.m. on March 30, one was above the coolant saturation temperature of about 550°F, 7 were above 350°F, and 2 were off-scale, indicating temperatures higher than 700°F. Upon request of NRR, Babcock and Wilcox is developing a procedure for use by the licensee in taking direct potentiometer readings from the off-scale thermocouples since the temperature scale limitation of 700°F is controlled by the process computer, not the thermocouple itself.

Reactor Coolant System (RCS) Parameters

The RCS parameters have remained relatively stable during the period. Gradual RCS cooldown continued to about 1:30 a.m., March 30, when temperature was slightly increased to allow additional margin between RCS operating parameters and Technical Specification minimum pressurization limits. Following are the primary system parameters over this period:

	10:00 a.m. <u>3/29/79</u>	7:00 p.m. <u>3/29/79</u>	12:01 a.m. <u>3/30/79</u>	3:00 a.m. <u>3/30/79</u>	5:00a.m. <u>3/30/79</u>
Pressurizer Level (inches)	348	321	326	342	354
Pressurizer Pressure (psi)	863	945	1023	1055	1053
Pressurizer Temperature (°F)	529	542	551	556	557
Loop A Core					
Inlet Temperature (°F)	281	277	275	278	274
Loop B Core					
Inlet Temperature (°F)	281	277	275	278	274

CONTINUED

Environmental Status

Two aerial surveys were conducted during the evening of March 29. The first flight was made about 8:15 p.m. during which measurements were taken in a circle around the site with a radius of about eight miles. No defined plume of radioactivity was detected, but residual pockets of radioactivity were identified at various points where the measured levels ranged from .025 to .050 milliroentgens per hours. (Natural background levels are about .005 to .015 milliroentgens per hour.) During the second flight, at about 10:30 p.m., a plume was detected northwest of the plant with a width equal to and confined within the boundaries of the river. The plume was touching down about one mile from the plant at Hill Island and then splitting into two parts - one on each side of Hill Island. Measurements at the east shoreline of the river, opposite Hill Island indicated about four milliroentgens per hour and at the shoreline on mile north of Hill Island near Olmstead Air Force Base about one milliroentgen per hour. Additional measurements at five miles from the plant were on the order of .010 milliroentgens per hour and are in agreement with the earlier flight.

During the early morning hours of March 30, an NRC monitoring team took radiation measurements from a vehicle traveling both sides of the Susquehanna River from 10 miles south of Three Mile Island to 4 miles north. Radiation levels were highest near Cly, a community just south of the facility on the west side of the river. The level at Cly was 0.15 milliroentgen per hour. All other locations had levels less than 0.05 milliroentgens per hour.

Other Information

At approximately 4:00 p.m. on March 29, two employees of Metropolitan Edison Co. received radiation exposures in excess of the quarterly limit of 3 rems. The employees, an operator and a chemist, entered the auxiliary building to collect a sample of primary coolant. Present estimates are that the operator received 3.1 rems and the chemist 3.4 rems.

The licensee released less than 50,000 gallons of slightly contaminated industrial wastes on March 29, 1979. This release was terminated at NRC request at approximately 6:00 p.m., March 29, 1979, because of concerns expressed by state representatives. At about 12:15 a.m. on March 30, NRC gave the licensee permission to resume releases of the slightly contaminated industrial wastes to the Susquehanna River. This action was coordinated with the office of the Governor of Pennsylvania and a press release was issued by the State. Representatives of the news media expressed concern that they were not informed of the planned resumption of the release prior to permission having been granted.

At 8:40 a.m., on March 30 the licensee began venting from the gaseous waste tanks. The impact of this operation is not yet known.

Contact: DThompson, IE x28111; EJordan, IE x 28111

Distribution: Transmitted H St 9:50

Chairman Hendrie
Commissioner Kennedy
Commissioner Gilinsky

Commissioner Bradford
Commissioner Ahearne

S. J. Chilk, SECY
C. C. Kammerer, CA
(For Distribution)

Transmitted: MNBB 10:02

L. V. Gossick, EDO
H. L. Ornstein, EDO
J. J. Fouchard, PA
N. M. Haller, MPA
R. G. Ryan, OSP
H. K. Shapar, ELD

P Bldg 10:15

H. R. Denton, NRR
R. C. DeYoung, NRR
R. J. Mattson, NRR
V. Stello, NRR
R. S. Boyd, NRR
(SS Bldg 10:42)
W. J. Dircks, NMSS

J. G. Davis, IE
Region II, III, IV, V 10:30

(MAIL)
J. J. Cummings, OIA
R. Minogue, SD

RII: 12:07

RIII: 12:20

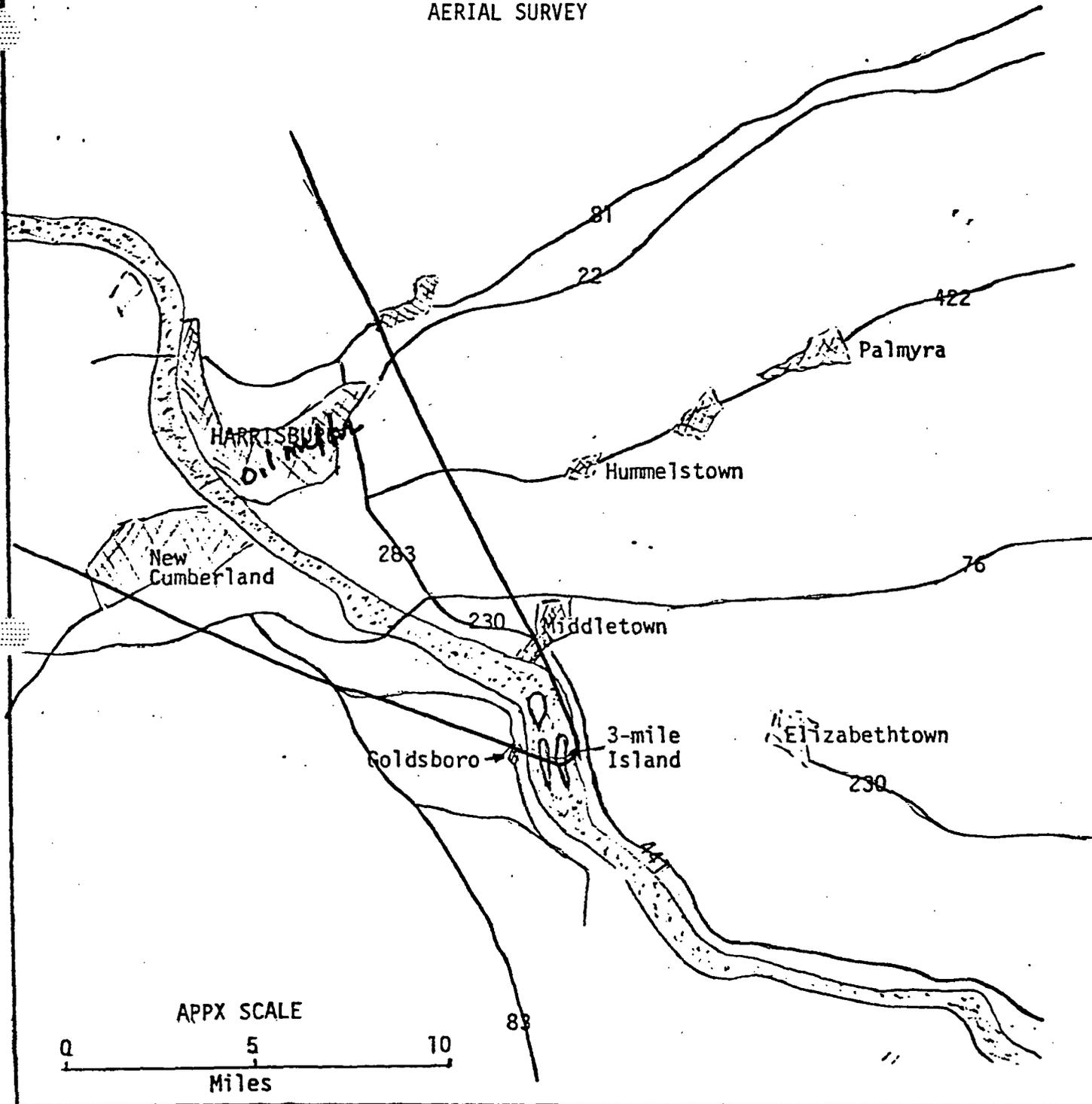
RIIV: 12:55

RIV:

Attachments (7):
Aerial Survey (6)
Ground-Level Survey (1)

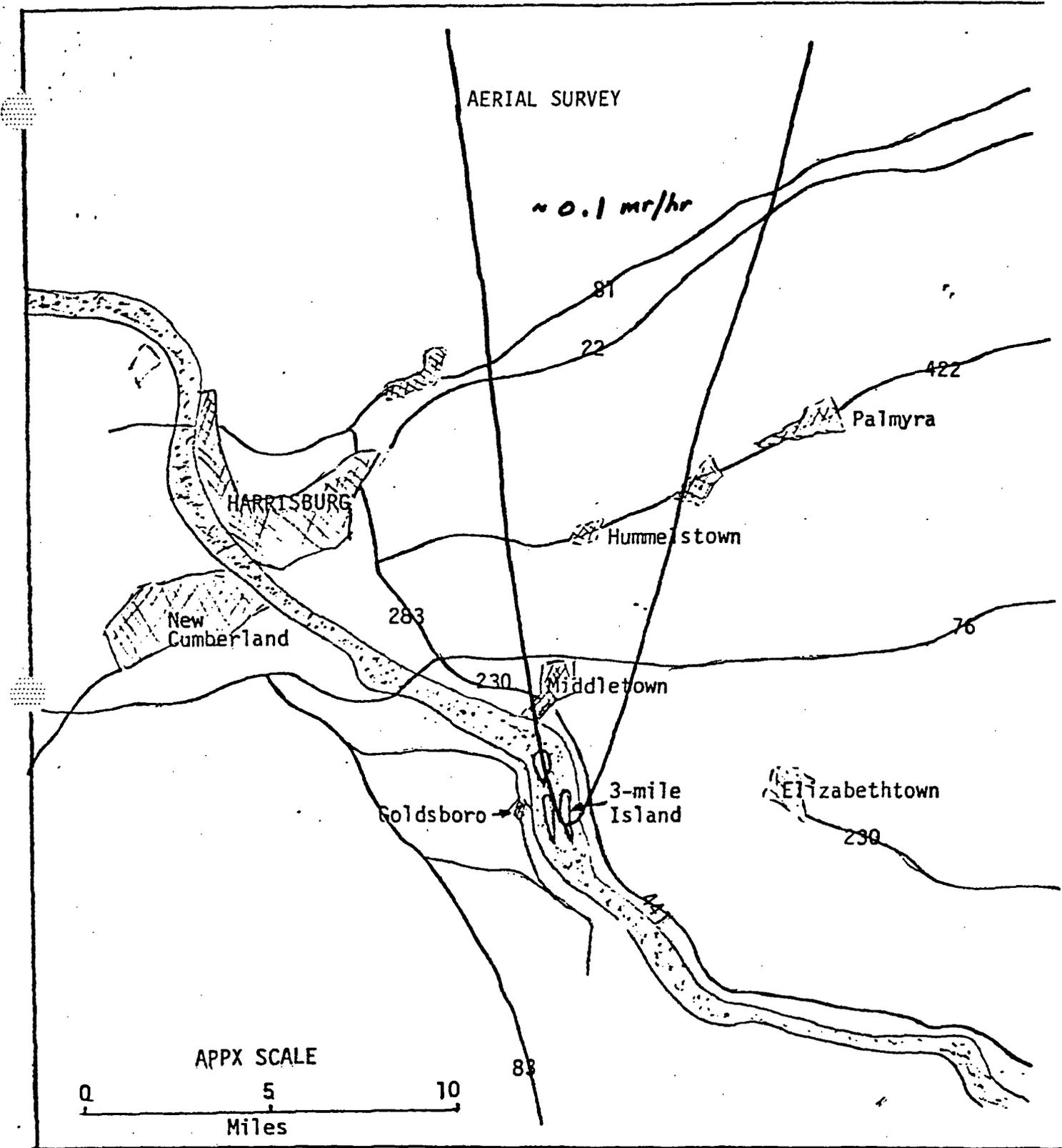
PRELIMINARY NOTIFICATION

AERIAL SURVEY



March 28, 1979 8:00 p.m.

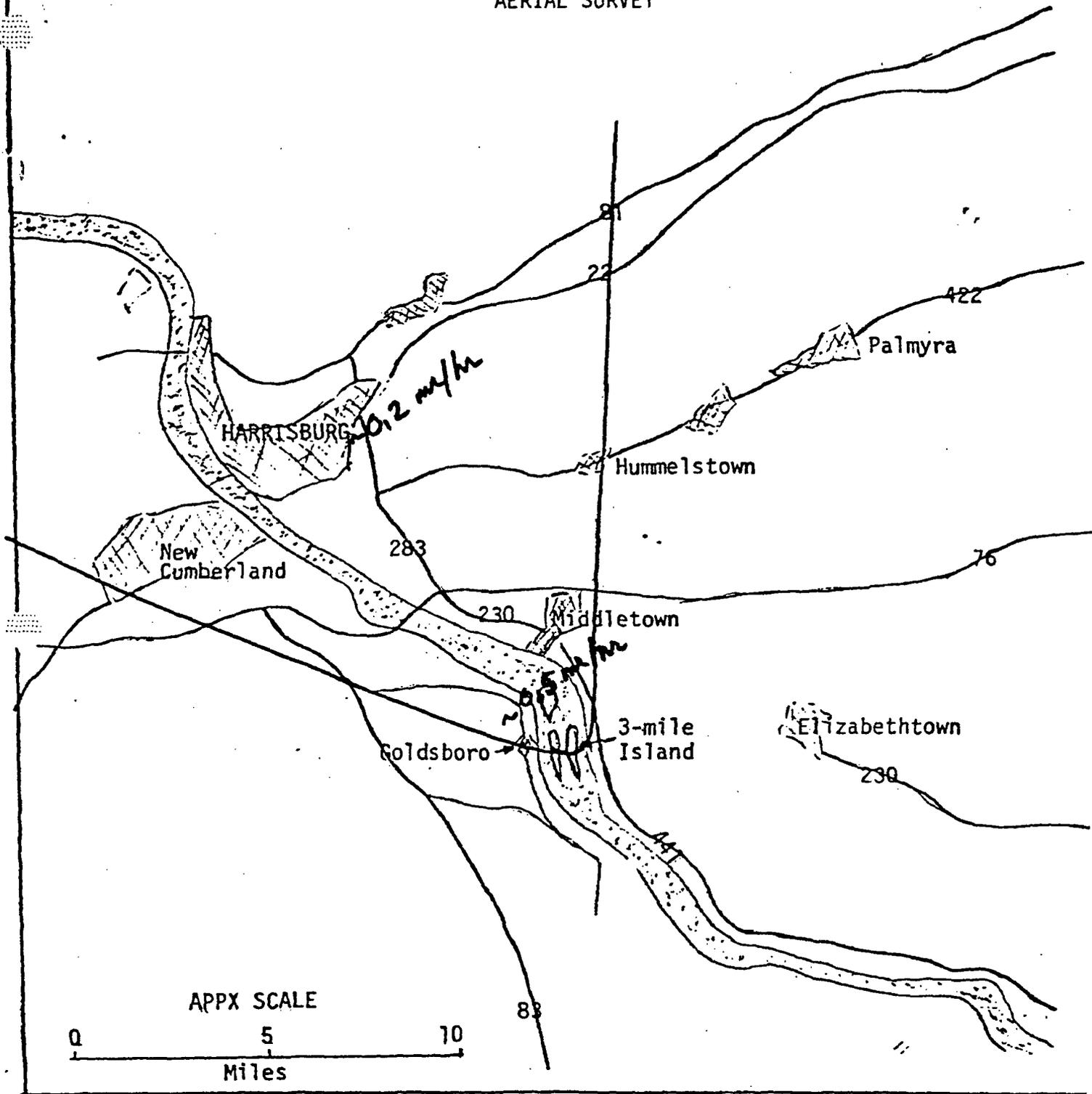
Plume in a N to NW direction. Primarily Xe-133. Over Harrisburg, radiation measurements in the plume showed about 0.1 mr/hr. At 10 miles from the site, the plume was about 4-5 miles wide; top of plume at about 3000 feet.



March 28, 1979 4:30 p.m.

Plume in a N to NE direction, about 30° sector.
 Primarily Xe-133. At distance of about 16 miles,
 radiation measurements in the plume were about 0.1 mr/hr.

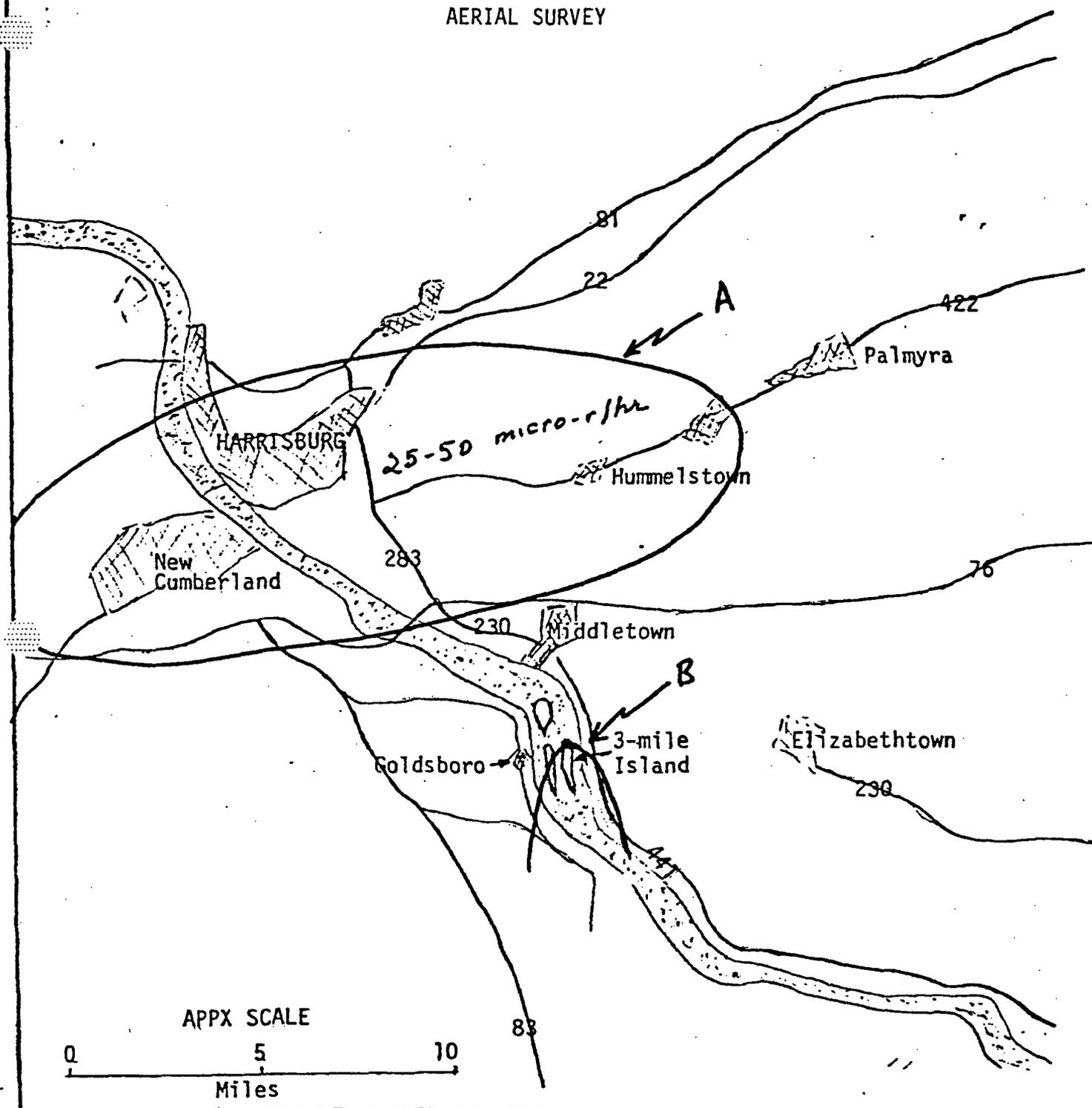
AERIAL SURVEY



March 29, 1979 10:45 a.m.

Plume in a N to NW direction. Primarily Xe-133.
Radiation measurements in the plume at about 10 miles
from plant in centerline of plume were 0.2 mr/hr; at
1 mile from plant, about 0.5 mr/hr maximum.

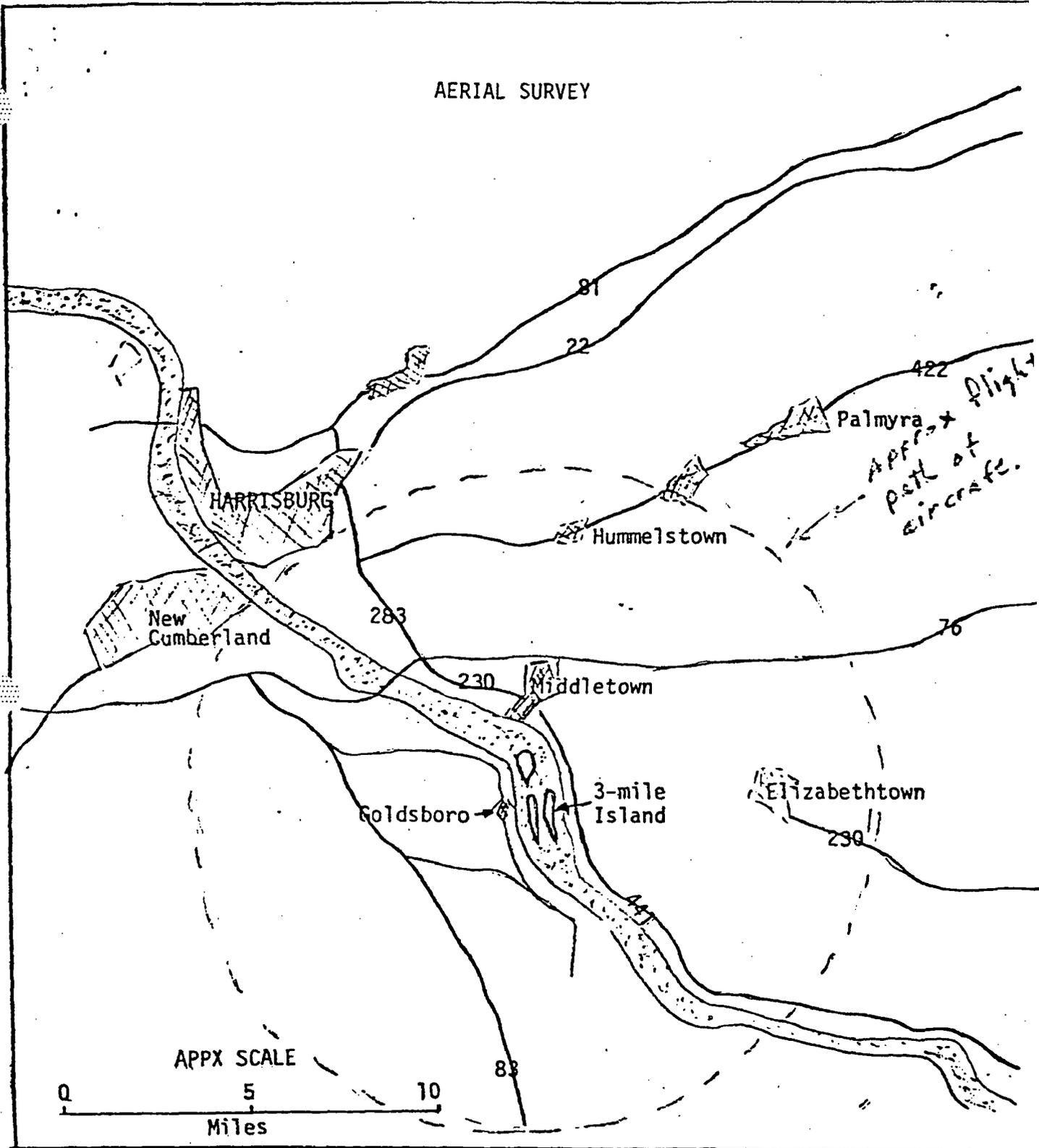
AERIAL SURVEY



March 29, 1979 5:00 p.m.

- A** Residual cloud (Xe-133) N to NW between Mechanicsburg and Hershey, Pennsylvania. Radiation measurements in the cloud in the microrentgen/hour range, highest readings in cloud center.
- B** Ground level measurements on the island indicated a plume in the southerly direction. Radiation measurements at fence line south of plant were 10 mr/hr, and one-half mile south of fence line, 0.5 mr/hr.

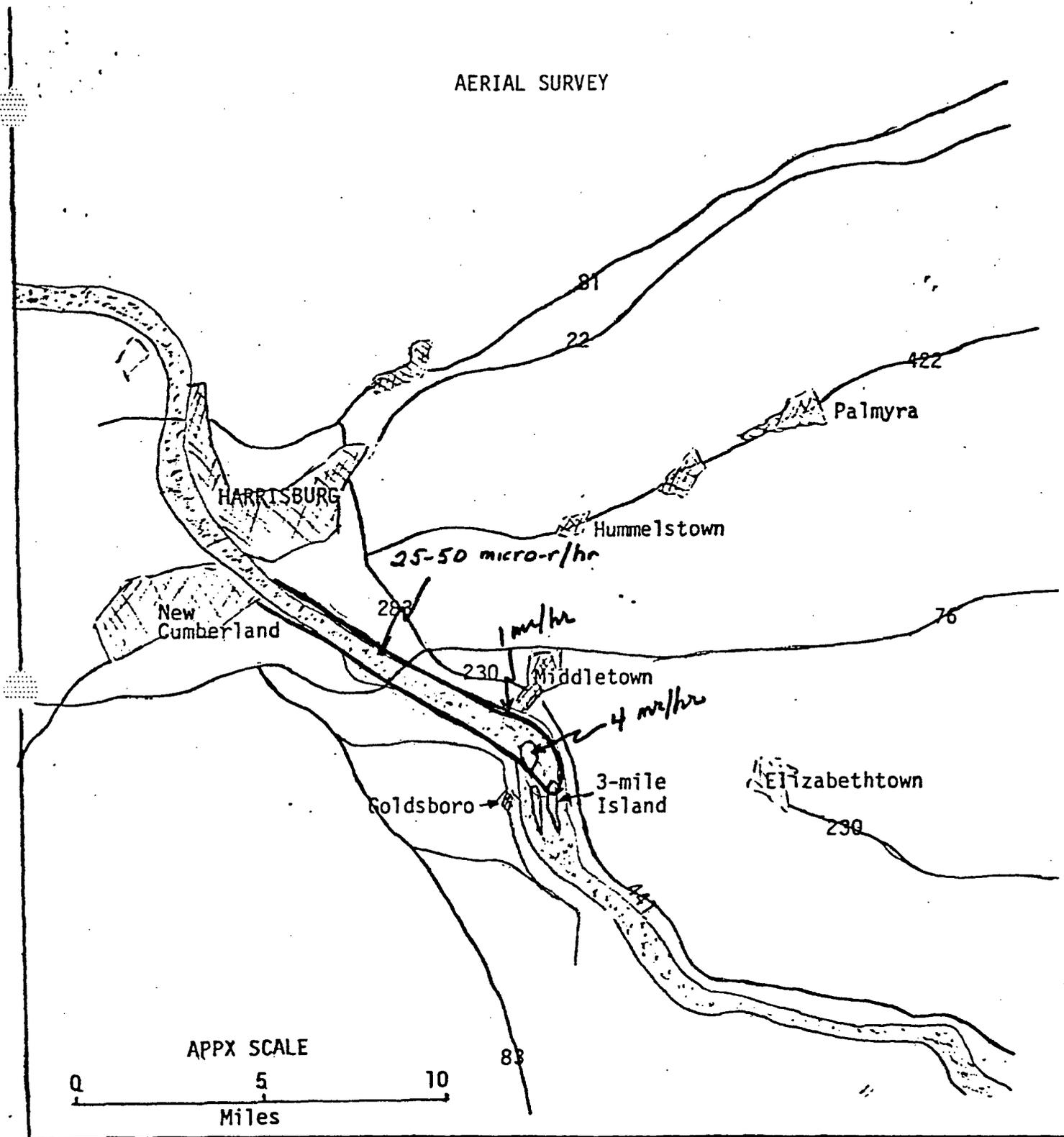
AERIAL SURVEY



March 29, 1979 8:00 p.m.

Survey aircraft circled the site at distance of about 8 miles at altitude of 1000 feet. No detectable plume; "pockets" of residual radioactivity were detected with radiation readings in the range of of 25 - 50 microrentgens/hour.

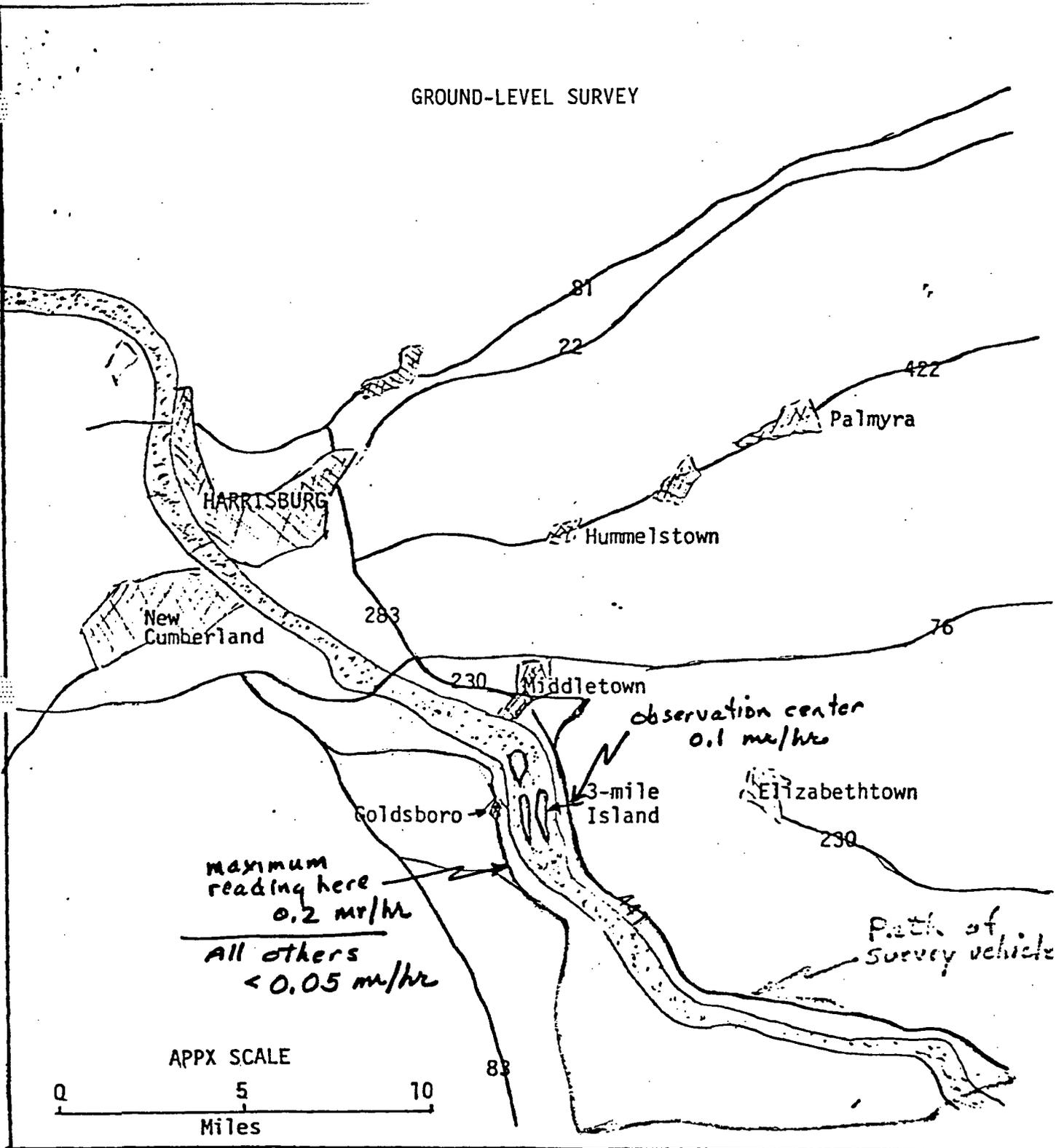
AERIAL SURVEY



March 29, 1979 10:30 p.m.

Plume in a NW direction, width about equal to width of river. Plume touches down about 1 mile from plant at Hill Island. Radiation measurements at east shore line at Hill Island, 4 mr/hr; one mile north of Hill Island, 1 mr/hr; and at five miles from the plant, 25 - 50 microroentgens/hr.

GROUND-LEVEL SURVEY



March 30, 1979 Time: approximately 4:00 a.m. - 5:30 a.m.

An NRC survey team took radiation measurements from a vehicle traveling both sides of the Susquehanna River.

Radiation levels were highest near Cly, a community just south of the plant on the west side of the river. The level at Cly was about 0.2 mr/hr. With the exception of the reading of 0.1 mr/hr at the Observation Center, the remainder of the readings on the route were less than 0.05 mr/hr.

March 30, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67C

This preliminary notification constitutes EARLY notice of event of POSSIBLE safety or public interest significance. The information presented is as initially received without verification or evaluation and is basically all that is known by IE staff on this date.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-520)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

There have been intermittent uncontrolled releases of radioactivity into the atmosphere from the primary coolant system of Unit 2 of the Three Mile Island Nuclear Power Plant near Harrisburg, Pennsylvania. The licensee is attempting to stop the intermittent gaseous releases by transferring the radioactive coolant water into the primary containment building. The levels of radioactivity being measured have been as high as 20 to 25 millirem per hour in the immediate vicinity of the site at ground level. Off-site levels were a few milliroentgen.

At about 11:30 a.m. EST, the Chairman of the NRC has suggested to Governor Thornburg of the Commonwealth of Pennsylvania that pregnant women and pre-school children in an area within five miles of the plant site be evacuated. Members of the NRC technical staff are at the site and efforts to reduce the temperatures of the reactor fuel are continuing. These temperatures have been coming down slowly and the final depressurization of the reactor vessel has been delayed. There is evidence of severe damage to the nuclear fuel. Samples of primary coolant containing high-levels of radioiodine and instruments in the core indicate high fuel temperatures in some of the fuel bundles, and the presence of a large bubble of non-condensable gases in the top of the reactor vessel.

Because of these non-condensable gases, the possibility exists of interrupting coolant flow within the reactor when its pressure is further decreased and the contained gases expand. Several options to reach a final safe state for the fuel are under consideration. In the meantime, the reactor is being maintained in a stable condition.

Contact: SEBryan, IE x28188 ELJordan, IE x28188

Distribution: Transmitted H St 4.15
Chairman Hendrie
Commissioner Kennedy
Commissioner Gilinsky

Commissioner Bradford
Commissioner Ahearne

S. J. Chilk, SECY
C. C. Kammerer, CA
(For Distribution)

Transmitted: MNBB 4.33
L. V. Gossick, EDO
H. L. Ornstein, EDO
J. J. Fouchard, PA
N. M. Haller, MPA
R. G. Ryan, OSP
H. K. Shapar, ELD

P. Bldg 4.17
H. R. Denton, NRR
R. C. DeYoung, NRR
R. J. Mattson, NRR
V. Stello, NRR
R. S. Boyd, NRR
SS Bldg 4.35
W. J. Dircks, IMSS

J. G. Davis, IE
Region I 4.30
II 4.33
III 4.43
IV 4.40
V 4.30
(MAIL) J. J. Cummings, OIA
R. Minogue, SD

IMMEDIATE

PRELIMINARY NOTIFICATION

March 30, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67D

This preliminary notification constitutes EARLY notice of an event of POSSIBLE safety or public interest significance. The information presented is as initially received without verification or evaluation and is basically all that is known by IE staff on this date.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

Gaseous radioactivity from the primary coolant system letdown has been contained in waste gas decay tanks since the last gaseous release at approximately 2:50 p.m. March 30, 1979. At the present reactor coolant letdown rate of approximately 20 gpm it may be necessary to make a planned release of radioactive gas tomorrow to prevent gas decay tank relief valve operation at its setpoint of 100 psi. The licensee has installed a temporary line from the gas decay system back to reactor containment which is under evaluation before being placed in operation. Containment pressure is being maintained slightly negative (-1 psi) as a result of fan cooler operation.

Reactor coolant temperature measured at fifty-two locations at the outlet of the core have continued to come down slowly. Three outlet temperature instruments continue to indicate above saturation temperature.

The NRC staff was informed by the licensee on Friday morning that examination of containment pressure data for March 28 indicates a pressure spike up to approximately 30 psi occurred at approximately 1:50 p.m. NRC personnel are evaluating the possibility that a hydrogen explosion was the cause of the containment internal pressure spike.

The reactor coolant path is through one reactor coolant pump and one steam generator. The steam generator is being fed by an auxiliary feed-pump. Several options for depressurizing the reactor and continuing cooldown via the residual heat removal system are under consideration.

CONTINUED

The volume of non-condensable gases in the reactor vessel has been estimated to be approximately 1000 to 1500 cubic feet at 1000 psi. This volume is estimated to result in a water level of several feet over the top of the fuel. The rate of growth of the bubble in the reactor vessel is estimated to be less than 50 cubic feet per day at 1000 psi.

The Director of the Office of Nuclear Reactor Regulation, the Director of the Region I Office of Inspection and Enforcement and the Director of the Division of Operating Reactors arrived at the site at approximately 2 p.m. today to direct NRC activities at the site and site vicinity. Representatives of HEW and EPA are providing coordination and assistance to the NRC at the Incident Response Center.

NRC personnel assembled at the TMI site and vicinity in addition to the upper management personnel consist of the following:

	RI	RII	RIII	Hq
Reactor Inspectors (IE)	8	5	4	
Health Physicists (IE)	12	12	10	
Health Physicists (SP)				4
Public Affairs	1	1		1
Reactor System Analysts (NRR)				13
Radition Waste Specialists (NRR)				4
Health Physicists (NRR)				6
Operating Licensing (NRR)				2
Total Staff			83	

CONTINUED

The following equipment has been assembled at or near the site for support of NRC operations:

Equipment	Location
1 NRC Instrument Van with 2 telephone lines	Observation Center
1 NRC Office Van	"
1 Office Trailer (Supplied by Licensee)	"
200 Hand-Held Portable Radios from US Forest Service	
Portable Health Physics Instrumentation	
3 Helicopters from DOE for survey and support	
2 Laboratory Vans DOE/Bettis	

A sophisticated communications pod from DOE/NEST will arrive tomorrow.

ENVIRONMENTAL STATUS:

At approximately 3 P.M. on March 30, 1979, NRC analysis of eight vegetation samples from the offsite areas showed no detectable activity. At 5.30 P.M. the Pennsylvania State Radiation Health Department reported that environmental water and air samples collected in the vicinity of the Three Mile Island Plant showed no detectable activity except for some Xenon-133 and Xenon-135. Milk sample analysis showed no activity levels above background.

Offsite ground level gamma surveys in the Middletown and Goldsboro areas between 3:00 and 6:00 P.M. on March 30, ranged from .01 to 1 milliroentgens per hour. An aerial survey was made by helicopter from 4:00 - 6:00 P.M. on March 30, the site was surveyed in concentric circles at approximately one mile intervals and at a height of 300 to 1,000 feet. The highest radiation readings were over the site and measured 8 to 10 milliroentgens per hour. In the plume the highest radiation readings were 6 to 8 milliroentgens per hour. The plume followed the river in a northwesterly direction and was not detectable beyond five to six miles from the site. Site ground level surveys conducted between 7:30 - 8:00 P.M. ranged from .01 to 1.8 milliroentgens per hour.

At 4 P.M. March 30, upper level winds were from the southeast. Forecast indicates precipitation in the form of thunderstorms moving in after 12 midnight, March 30. At 5:00 P.M. winds onsite at Three Mile Island were reported at 2 to 3 miles per hour generally from east to west.

Contact: EMHoward, IE x28111; EJordan, IE x28111

Distribution: Transmitted H St 1:10 a 3/31
Chairman Hendrie Commissioner Bradford S. J. Chilk, SECY
Commissioner Kennedy Commissioner Ahearne C. C. Kammerer, CA
Commissioner Gilinsky (For Distribution)

Transmitted: MNBB 1:17 P Bldg 1:25 J. G. Davis, IE
L. V. Gossick, EDO H. R. Denton, NRR Region _____
H. L. Ornstein, EDO R. C. DeYoung, NRR
J. J. Fouchard, PA R. J. Mattson, NRR
N. M. Haller, MPA V. Stello, NRR (MAIL)
R. G. Ryan, OSP R. S. Boyd, NRR J. J. Cummings, OIA
H. K. Shapar, ELD (SS Bldg 1:33) R. Minogue, SD
W. J. Dircks, NMSS

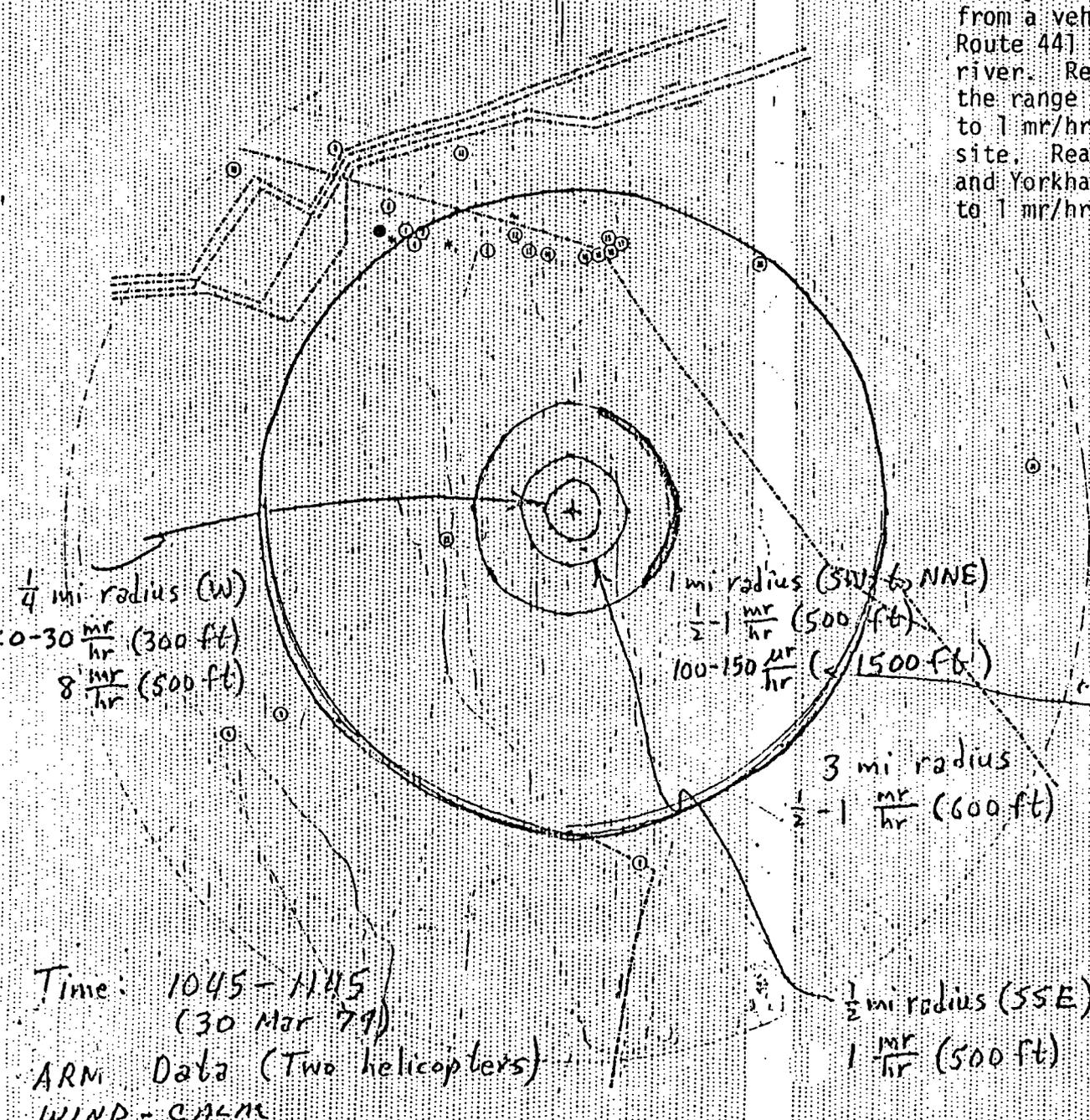
White House Situation Room 12:55 a.m. 3/31/79
EPA _____
FDA/BRH _____
DOE/EOC 2:00 a.m. 3/31

Attachment (1)
Radiation Survey Map

IMMEDIATE

PRELIMINARY NOTIFICATION

At approximately 10:30 am, an NRC survey team took survey measurements from a vehicle traveling south on Route 441 on the eastern side of the river. Readings were generally in the range of 3 mr/hr near the site to 1 mr/hr five miles south of the site. Readings in the Middletown and Yorkhaven areas ranged from 1 to 1 mr/hr at approximately 11:15 am.



Symbol	Description	Count
⊙	Survey point 1	1
⊙	Survey point 2	1
⊙	Survey point 3	1
⊙	Survey point 4	1
⊙	Survey point 5	1
⊙	Survey point 6	1
⊙	Survey point 7	1
⊙	Survey point 8	1
⊙	Survey point 9	1
⊙	Survey point 10	1
⊙	Survey point 11	1
⊙	Survey point 12	1
⊙	Survey point 13	1
⊙	Survey point 14	1
⊙	Survey point 15	1
⊙	Survey point 16	1
⊙	Survey point 17	1
⊙	Survey point 18	1
⊙	Survey point 19	1
⊙	Survey point 20	1
⊙	Survey point 21	1
⊙	Survey point 22	1
⊙	Survey point 23	1
⊙	Survey point 24	1
⊙	Survey point 25	1
⊙	Survey point 26	1
⊙	Survey point 27	1
⊙	Survey point 28	1
⊙	Survey point 29	1
⊙	Survey point 30	1
⊙	Survey point 31	1
⊙	Survey point 32	1
⊙	Survey point 33	1
⊙	Survey point 34	1
⊙	Survey point 35	1
⊙	Survey point 36	1
⊙	Survey point 37	1
⊙	Survey point 38	1
⊙	Survey point 39	1
⊙	Survey point 40	1
⊙	Survey point 41	1
⊙	Survey point 42	1
⊙	Survey point 43	1
⊙	Survey point 44	1
⊙	Survey point 45	1
⊙	Survey point 46	1
⊙	Survey point 47	1
⊙	Survey point 48	1
⊙	Survey point 49	1
⊙	Survey point 50	1
⊙	Survey point 51	1
⊙	Survey point 52	1
⊙	Survey point 53	1
⊙	Survey point 54	1
⊙	Survey point 55	1
⊙	Survey point 56	1
⊙	Survey point 57	1
⊙	Survey point 58	1
⊙	Survey point 59	1
⊙	Survey point 60	1
⊙	Survey point 61	1
⊙	Survey point 62	1
⊙	Survey point 63	1
⊙	Survey point 64	1
⊙	Survey point 65	1
⊙	Survey point 66	1
⊙	Survey point 67	1
⊙	Survey point 68	1
⊙	Survey point 69	1
⊙	Survey point 70	1
⊙	Survey point 71	1
⊙	Survey point 72	1
⊙	Survey point 73	1
⊙	Survey point 74	1
⊙	Survey point 75	1
⊙	Survey point 76	1
⊙	Survey point 77	1
⊙	Survey point 78	1
⊙	Survey point 79	1
⊙	Survey point 80	1
⊙	Survey point 81	1
⊙	Survey point 82	1
⊙	Survey point 83	1
⊙	Survey point 84	1
⊙	Survey point 85	1
⊙	Survey point 86	1
⊙	Survey point 87	1
⊙	Survey point 88	1
⊙	Survey point 89	1
⊙	Survey point 90	1
⊙	Survey point 91	1
⊙	Survey point 92	1
⊙	Survey point 93	1
⊙	Survey point 94	1
⊙	Survey point 95	1
⊙	Survey point 96	1
⊙	Survey point 97	1
⊙	Survey point 98	1
⊙	Survey point 99	1
⊙	Survey point 100	1

NOTE
micro r/hr

Time: 1045 - 1145
(30 Mar 79)
ARM Data (Two helicopters)
WIND - CALM

INDUSTRIAL & MILITARY FACILITIES
WITHIN A 5 MILE RADIUS
THREE MILE ISLAND NUCLEAR STATION UNIT 1

FIGURE 2-SA
(AM. 30 9-27-79)

IMMEDIATE

PRELIMINARY NOTIFICATION

March 31, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67E

This immediate preliminary notification constitutes an update of event of safety and public interest significance. The information presented is as initially received without verification or evaluation and is basically all that is known by NRC staff at this time.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

Reactor cooling continues using the 1A main reactor coolant pump with steam generator A steaming to the main condenser. Changes to this cooling method are not planned for the near term. An operability status of equipment is being compiled for use as backup in the event of failure of existing operating equipment.

The hydrogen recombiner is in an operable status; however, shielding of its piping and components is not fully installed and is presently considered inadequate. Lead for shielding has been located and will be moved to the site on an expedited basis. Calculations of hydrogen in containment show that the present concentration is less than 4%, the staff's limit on allowed concentration to ensure an explosive mixture is not obtained. Attempts are being made to obtain a containment atmosphere sample.

The waste gas decay tank pressures were 80 psi at 10:15 p.m. on March 30 and had been relatively constant for about five hours. The tank is set to relieve pressure at 100 - 110 psi. The radiation field (60 R/hr at contact) prevents resetting relief points.

Reactor coolant temperatures measured by incore thermocouples at 52 locations presently show only one location above saturation temperature. Temperatures in the core as measured from outlet thermocouples are gradually decreasing. Other system parameters are remaining stable.

Environmental Status

Three ARMS flights of one-hour length were conducted beginning at 9:30 p.m. on March 30, and at midnight and 3:00 a.m. on March 31. At a

CONTINUED

distance of one mile from the plant, maximum readings ranged from 0.5 milliroentgens per hour (mr/hr) to 1.5 mr/hr. At the 18 mile point, readings of 0.1 to 0.2 mr/hr were obtained during the two earlier surveys and 0.5 mr/hr during the latest. Flights are being made at approximately three hour intervals.

Offsite ground level gamma surveys in the Middletown area and north, between 9:30 p.m. on March 30 and 1:00 a.m. on March 31, indicated levels from 0.2 to 0.5 mr/hr. These measurements were taken in the general direction of the plume measured in aerial surveys.

At 3:00 p.m. on March 29, (prior to the releases of March 30) the licensee pulled thermoluminescent dosimeters from 17 fixed positions located within a 15 mile radius of the site. The dosimeters had been in place for three months and had been exposed for about 32 hours after the incident. Only two dosimeters showed elevated exposures above normal levels. The highest reading observed was on Three Mile Island, 0.4 miles north of the reactor at the North Weather Station. At this location, the quarterly accumulated exposure was 81 mr, approximately 65 mr above the normal quarterly exposure rate. The other high exposure was observed at North Bridge, 0.7 miles NNE of the reactor at the entrance to the site. At this location, the total quarterly accumulated exposure was 37 mr or approximately 22 mr above the normal quarterly exposure rate.

During the evening milking hours on March 30, milk samples were collected by the Pennsylvania Department of Environmental Resources at the following locations:

- Harrisburg (2 sites)
- York
- Middletown
- Bainbridge
- Etters

Analyses showed no detectable radioiodine. The cows had been fed on stored feed but had been outside for exercise.

The Pennsylvania Department of Environmental Resources also collected water samples at filtration plants at Columbia, PA (for the City of Lancaster) and Wrightsville on March 30 in the morning and early afternoon. Both sample points are downstream of Three Mile Island. No detectable activity was found.

CONTINUED

Contact: DThompson, IE x28111 NCMoseley, IE x28111

Distribution: Transmitted H St 9:04
Chairman Hendrie Commissioner Bradford
Commissioner Kennedy Commissioner Ahearne
Commissioner Gilinsky

S. J. Chilk, SECY
C. C. Kammerer, CA
(For Distribution).

Transmitted: MNBB 9:08
L. V. Gossick, EDO
H. L. Ornstein, EDO
J. J. Fouchard, PA
N. M. Haller, MPA
R. G. Ryan, OSP
H. K. Shapar, ELD
P. Bldg 9:15
H. R. Denton, NRR
R. C. DeYoung, NRR
R. J. Mattson, NRR
V. Stello, NRR
R. S. Boyd, NRR
SS Bldg 9:30
W. J. Dircks, NMSS

J. G. Davis, IE
Region 5 9:24

(MAIL)
J. J. Cummings, OIA
R. Minogue, SD

White House Situation Room _____
EPA 10:15
FDA/BRH
DOE/EOC 10:01

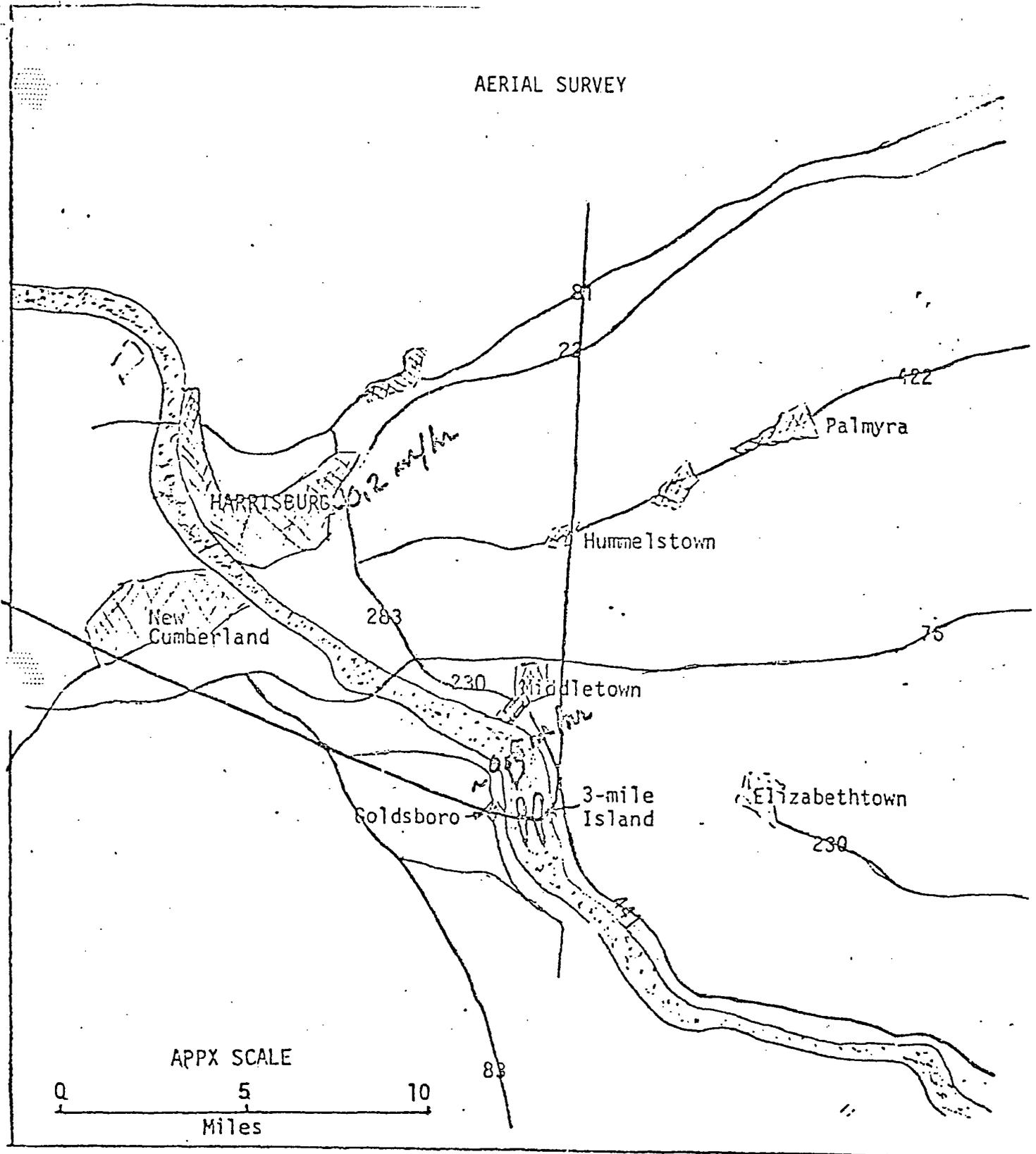
2II - 9:32
2III - 9:40
2IV - 9:48
2V - ~~10:00~~
5:07

Attachment (1)
Radiation Survey Map

IMMEDIATE

PRELIMINARY NOTIFICATION

AERIAL SURVEY



March 29, 1979 10:45 a.m.

Plume in a N to NW direction. Primarily Xe-133.
Radiation measurements in the plume at about 10 miles
from plant in centerline of plume were 0.2 mr/hr; at
1 mile from plant, about 0.5 mr/hr maximum.

IMMEDIATE

PRELIMINARY NOTIFICATION

g

March 31, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67F

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 5:30 pm date 3/31/79.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

There has been no change in the method of cooling the reactor since the previous report (PNO-79-67E). Reactor coolant temperatures measured by incore thermocouples at 52 locations have continued to decrease. At present none of the temperature readings is above saturation temperature for this pressure (554°F). System parameters remain stable. There has been a slight drop in pressurizer level from 215 to 191 inches.

Efforts continue to complete installation of components and piping on the hydrogen recombiner. Approximately 220 tons of lead shielding in various shapes and forms has arrived, or is on the way, to the site. Lead shielding is being installed around the recombiner. A decision to use the recombiner has not yet been made. Two samples of containment atmosphere have been analyzed which show hydrogen concentrations of 1.7 and 1.0%.

Efforts continue to estimate the volume of the noncondensable gas bubble above the core. Licensee calculations of the size of the bubble at 2:40 pm was 880 cubic feet at 875 psig. At about 4:20 pm this was recalculated by the licensee to be 621 cubic feet at 875 psig. This is being further evaluated.

Environmental Status

Three ARMS flights were conducted at about 6:00 a.m., 9:00 a.m., and 12:00 noon on March 31. All flights reflected a rather stable situation. Maximum readings in the plume were from 1.5 to 2.5 milliroentgens per hour (mr/hr) at a distance of one mile from the plant, from 0.5 to 1.0 mr/hr out to 7 miles, and 0.1 to 0.2 mr/hr beyond 10 miles. The plume width is about 1-1/2 to 2 miles. No radioiodines have been detected in the plume. Offsite ground level gamma surveys performed in the predominant wind direction indicated maximum levels of about 2 mr/hr at about 1/2 mile from the site in the direction of the plume. The wind was from the SSW at the time of the

CONTINUED

ARMS flights. At about 1 PM the winds shifted and are now blowing in a south easterly direction.

International Contacts

NRC's Office of International Programs (OIP) has prepared daily status reports, transmitted by Immediate Department of State telegrams to official NRC contacts in the 25 foreign countries with which NRC has regular official relations. OIP is also receiving many foreign telephone calls.

Two senior safety experts from the Federal Republic of Germany (FRG) arrived late March 30 and were briefed by NRC experts at the Operations Center, late March 30 and during March 31. Two French experts will arrive April 1. Washington Representatives or senior visitors of Japan, FRG, and Sweden also have been briefed in the Operations Center. OIP also has been briefing the President of the AECB of Canada, who offered to send any AECL or AECB experts who could be of assistance.

Contact with Licensee

NRC Regional Offices are transmitting to the utilities with operating licenses summary information (in the form of Preliminary Notifications) as they are prepared.

Contact: DThompson, IE x28111 EMHoward, IE x28111

Distribution: Transmitted H St 7:06p.

Chairman Hendrie

Commissioner Kennedy

Commissioner Gilinsky

Commissioner Bradford

Commissioner Ahearne

S. J. Chilk, SECY
C. C. Kammerer, CA
(For Distribution)

Transmitted: MNBB 7:10p

L. V. Gossick, EDO

H. L. Ornstein, EDO

J. J. Fouchard, PA

N. M. Haller, MPA

R. G. Ryan, OSP

H. K. Shapar, ELD

P. Bldg 7:15p

H. R. Denton, NRR

R. C. DeYoung, NRR

R. J. Mattson, NRR

V. Stello, NRR

R. S. Boyd, NRR

SS Bldg 7:20p

W. J. Dircks, NMSS

J. G. Davis, IE
Region I - 7:50
Region II - 7:55
Region III - 8:15
Region IV - 8:21
Region V - 7:45

(MAIL)

J. J. Cummings, OIA
R. Minogue, SD

White House Situation Room 7:25p

EPA -

FDA/BRH -

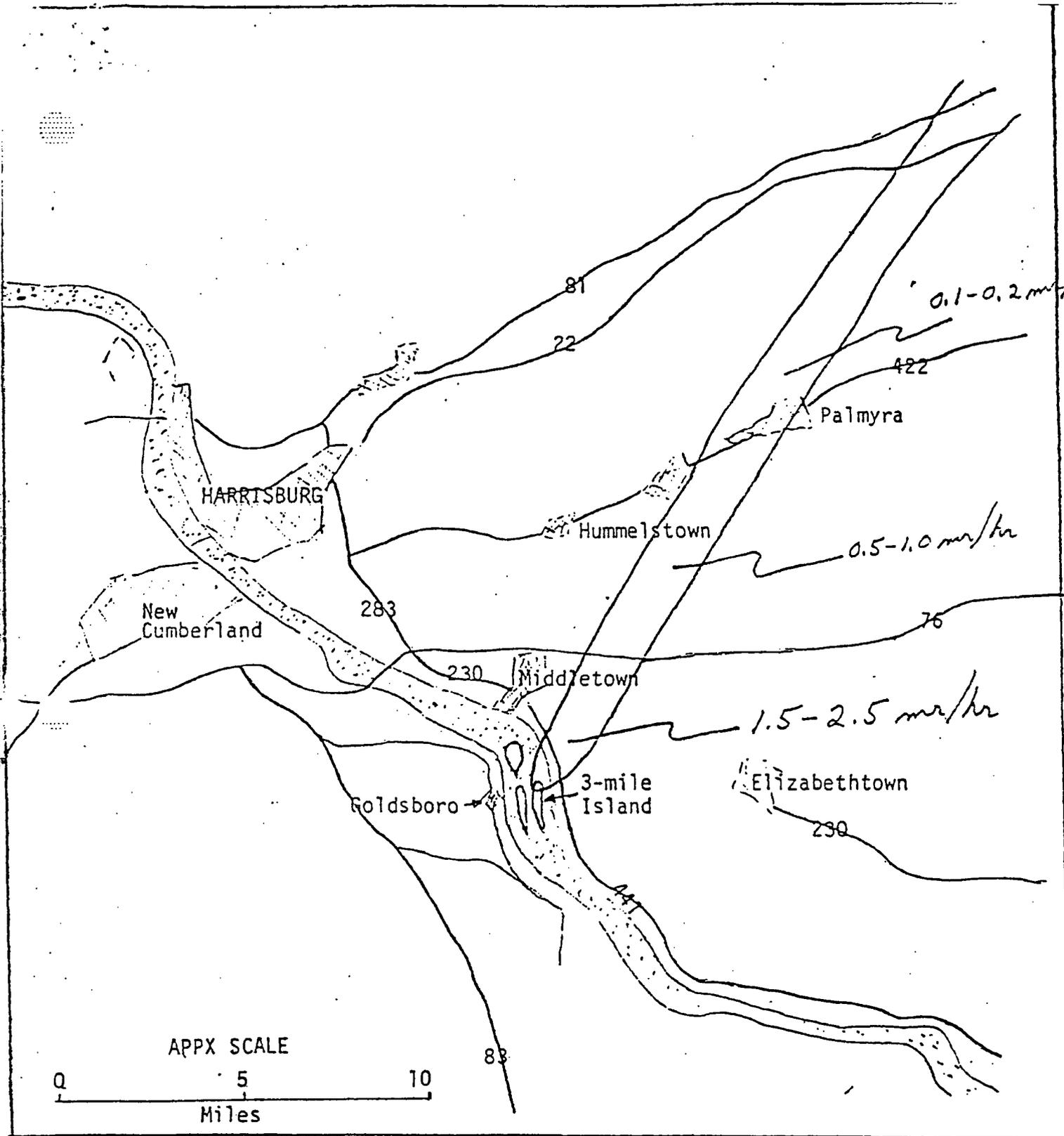
DOE/EOC 7:05p.

Attachment (1)

Radiation Survey Map

IMMEDIATE

PRELIMINARY NOTIFICATION



March 31, 1979

AERIAL SURVEY plume direction and radiation readings shown above conducted at 6:00 & 9:00 AM and 12:00 noon.

IMMEDIATE

PRELIMINARY NOTIFICATION

April 1, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67G

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 am on 4/1/79.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

There has been no substantial change in the primary system temperature and pressure. Incore thermocouples continue to show a downward trend.

Actions are underway to vent radioactive gases from the waste gas decay tank to the containment building. This will be performed through a temporary pipeline.

The licensee plans to hook up and shield two recombiners prior to initiating recombining operations to reduce the concentrations of hydrogen in the containment. The licensee estimates that it will require about 24 hours before the recombiners will be operational.

Calculated values by the licensee of the volume of noncondensable gases above the core continue to vary. The NRC staff has been unable to draw meaningful conclusions from this data.

Environmental Status

ARMS flights at approximately 3-hour intervals were continued on March 31 and the early hours of April 1. Survey results reflected stable conditions. Maximum readings were 2 mR/hr in the plume at a distance of 1 mile from the plant. The plume width has been about 1.5 miles out to a distance of 10 miles. At a distance of 10 miles, plume readings were 0.15 mR/hr. Milk was collected at nine stations on March 31; no radioactive iodine was detected. Offsite ground level gamma surveys performed in the predominant wind direction showed a maximum of 0.6 mR/hr at 500 yards from the plant to a low of 0.06 mR/hr at distances of 2 to 3 miles. An exception was noted during the collection of a sample from the waste gas decay tank when gamma levels of 3 mR/hr were observed at a distance of 500 yards east of the plant.

CONTINUED

Other Information

Analysis of a sample of primary coolant indicated that the principal isotopes released from the fuel were iodine, cesium and noble gases. A preliminary evaluation of the analytical results related to these more volatile isotopes indicates high fuel temperatures existed, perhaps for extended periods. However, ratios among isotopes indicate that the less volatile isotopes, such as strontium, were released to the coolant in quantities characteristic of releases from the gaps of the fuel and, therefore, based on this preliminary evaluation, melting of the fuel is not considered likely to have occurred.

Analysis of a containment building gas sample showed the following results:

<u>Isotope</u>	<u>Concentration (microcuries/milliliter)</u>
Xe-133	676
Xe-133m	16
Xe-135	8.1
I-131	6.3×10^{-2}
I-133	< 0.03

NRC representatives at the facility were informed at 10:45 p.m. on March 31 that there would be an attempt to sabotage the facility during the night. The FBI, Pennsylvania State Police and the licensee were notified.

Contact: DThompson, IE x28111 NCMoseley, IE x28111

Distribution: Transmitted H St 0828
Chairman Hendrie Commissioner Bradford S. J. Chilk, SECY
Commissioner Kennedy Commissioner Ahearne C. C. Kammerer, CA
Commissioner Gilinsky (For Distribution)

Transmitted: MNBB 0833 P. Bldg 0826 J. G. Davis, IE
L. V. Gossick, EDO H. R. Denton, NRR Region I SITE 11:38
H. L. Ornstein, EDO R. C. DeYoung, NRR Region II -5:50P. AND GRIER
J. J. Fouchard, PA R. J. Mattson, NRR Region III 6:45P.
N. M. Haller, MPA V. Stello, NRR Region IV -5:38P
R. G. Ryan, OSP R. S. Boyd, NRR Region V -6:20P.
H. K. Shapar, ELD SS Bldg 0845 (MAIL)
W. J. Dircks, NMSS J. J. Cummings, OIA
R. Minogue, SD

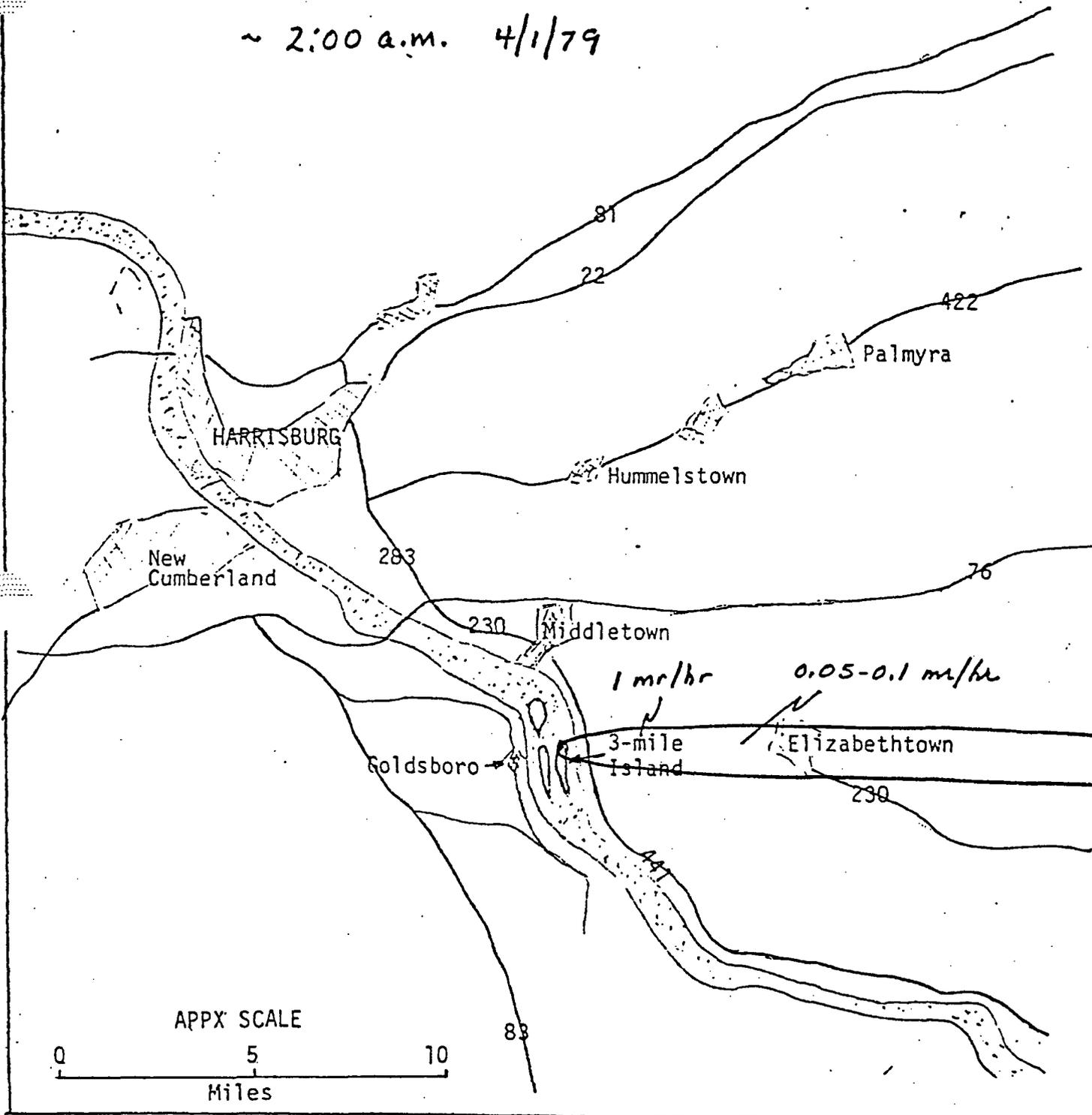
White House Situation Room _____
EPA _____
FDA/BRH _____
DOE/EOC 0840

Attachment (1)
Radiation Survey Map

IMMEDIATE

PRELIMINARY NOTIFICATION

AERIAL SURVEY
~ 2:00 a.m. 4/1/79



IMMEDIATE

PRELIMINARY NOTIFICATION

April 2, 1979

g

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67H

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 12 noon on 4/2/79.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

Reactor pressure is being held at about 1000 psi. Incore thermocouples continue to show a decrease in fuel channel temperatures, with all measurements below about 475 degrees F. Bulk core inlet and outlet temperatures are 280 degrees F. At 11 p.m., April 1, a containment air sample indicated 2.3% hydrogen.

Further analyses and consultations with experts has led to the development of a strong concensus that the net oxygen generation rate inside the noncondensable bubble in the reactor is much less than originally conservatively estimated. Also, measurements at the plant appear to indicate that the volume of gases within the bubble is being significantly reduced. Further developments are being closely followed to confirm these favorable indications.

Action on Other Facilities

The Three Mile Island Unit 2 (TMI-2) pressurized water reactor was supplied by Babcock & Wilcox (B&W). All utilities with an operating B&W reactor were sent an NRC Bulletin yesterday to provide them with information about the TMI-2 incident; require a prompt review of their plant conditions, and to effect action to prevent such an incident. NRC inspectors are being sent to each licensed B&W reactor to provide increased inspection coverage. Additional reactor shutdowns or power reductions are not being required by the NRC at this time.

Environmental Status

Thirty-seven thermoluminescent dosimetry (TLD) stations were established by the NRC at distances from about one mile to about 12 miles from the plant. Multiple dosimeters are placed at each location - one will be

CONTINUED

left in place for a cumulative dose measurement; another is pulled and replaced each day. TLD's collected on April 1, 1979 indicated the following dose rates in populated areas:

<u>Location</u>	<u>Dose Rate (Milliroentgens per Hour)</u>
Middletown	0.044
Goldsboro	0.13
Goldsboro	0.040
Lewisberry	0.053
Pleasant Grove	0.041
York Haven	0.074
Conewago Falls	0.044
Emigsville	0.053

The highest dosimeter reading was recorded at a location $\frac{1}{2}$ mile ENE of the plant. The average dose rate at this location was 1.1 milliroentgen per hour.

For comparison purposes, the licensee's environmental report for 1977 when one unit was operating, indicated that the average dose rate at offsite stations located within three miles of the plant was 0.007 mR/hr.

Calculations using the TLD data indicate a population dose of approximately 200 man-rems for the 24-hour period. This means there was an average radiation dose of about 0.3 millirems per person in the population within a 20-mile radius of the plant.

ARM's flights were continued at three-hour intervals on April 1, and 2, 1979. The plume readings were essentially the same for all the flights. Direction of the plume varied from SW to WNW. The maximum level at one mile from the plant was about 3 mR/hr at an altitude of 500 feet. At three miles, the levels were from 0.1 to 0.5 mR/hr.

Offsite ground level surveys taken between 11:00 a.m. April 1, and 4:30 a.m. April 2, on both sides of the river in a southerly direction generally showed levels of 0.01 to 0.04 mR/hr.

Nine milk samples collected and analyzed by the State of Pennsylvania on April 1 showed no detectable radioiodine.

The licensee reported results from 5 milk samples taken from four locations around the plant collected the evening of March 30, 1979. The samples included one sample of goat's milk and four samples of cow's milk. The highest level was reported for the goat's milk and was 41 picocuries per liter (pCi/l.). The highest level in cow's milk was 8.4 pCi/l. The NRC has estimated the thyroid dose to a child drinking milk with concentrations of radioiodine at 41 pCi/l to be about 0.2 millirem per day. The thyroid dose to an adult would be about 0.07 millirem per day. Each of these samples indicated levels slightly above normal background levels for radioiodine.

CONTINUED

The Bureau of Radiological Health, HEW, also reported identifying radioiodine in six samples of milk collected on March 31, 1979 from four locations around the plant. Analyses of the samples identified near background levels of radioiodine. The levels ranged from the minimum detectable limit to about 40 pCi/l.

For comparison, the licensee's environmental report for 1977 showed observations of 0.74 to 31 pCi/l of I-131 in milk throughout the year previous to the incident. At 12,000 pCi/l, the U.S. Department of Health, Education, and Welfare recommends placing dairy herds on stored feed. Local herds are already on stored feed.

Contact: DThompson, IE x28487 NCMoseley, IE x28160

Distribution: Transmitted H St 3:50 p.m.
Chairman Hendrie Commissioner Bradford
Commissioner Kennedy Commissioner Ahearne
Commissioner Gilinsky

S. J. Chilk, SECY
C. C. Kammerer, CA
(For Distribution)

Transmitted: MNBB 4:00 p.m.
L. V. Gossick, EDO
H. L. Ornstein, EDO
J. J. Fouchard, PA
N. M. Haller, MPA
R. G. Ryan, OSP
H. K. Shapar, ELD
P. Bldg 4:05 p.
H. R. Denton, NRR
R. C. DeYoung, NRR
R. J. Mattson, NRR
V. Stello, NRR
R. S. Boyd, NRR
SS Bldg 4:05
W. J. Dircks, NMSS

J. G. Davis, IE
Region I 4:11
Region II 4:25
Region III 4:35
Region IV 4:45
Region V 4:45
(MAIL) 5:00
J. J. Cummings, OIA
R. Minogue, SD

Site - 4:30

White House Situation Room _____
(Handcarry _____)
EPA _____
FDA/BRH _____
DOE/EOC 5:05
FAA _____
FDAA 4:45

Attachment 1:
Radiation Dose Rate Map

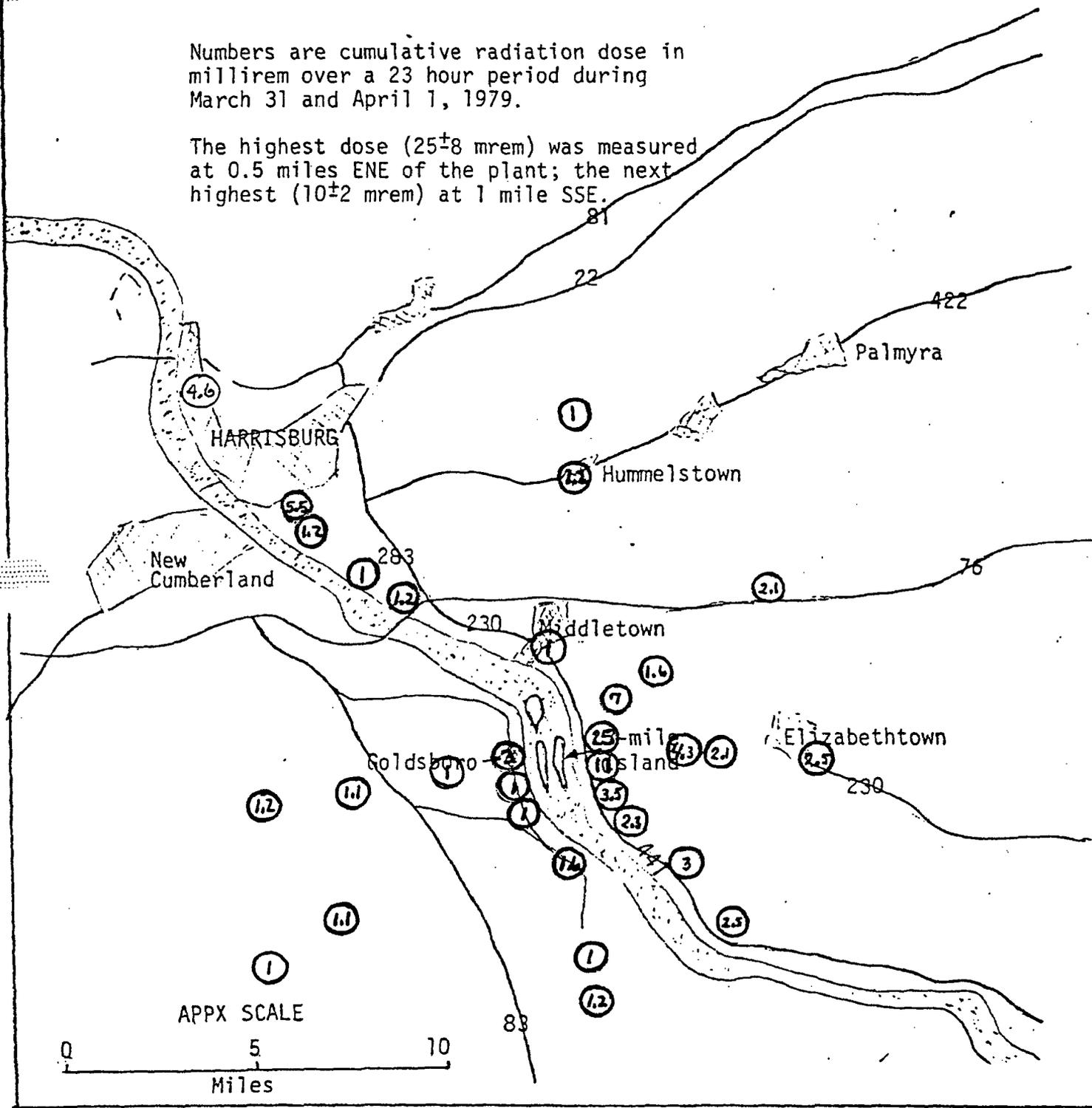
IMMEDIATE

PRELIMINARY NOTIFICATION

NRC THERMOLUMINESCENT DOSIMETER (TLD) DATA

Numbers are cumulative radiation dose in millirem over a 23 hour period during March 31 and April 1, 1979.

The highest dose (25 ± 8 mrem) was measured at 0.5 miles ENE of the plant; the next highest (10 ± 2 mrem) at 1 mile SSE.



IMMEDIATE

PRELIMINARY NOTIFICATION

April 3, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67I

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on 4/3/79.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

Reactor pressure remains near 1000 psi, with bulk core coolant inlet and outlet temperatures at 280°F. Core thermocouple readings are relatively unchanged and indicate a maximum temperature of 477°F which is well below saturation temperature for this pressure. (Only 3 thermocouples read above 400°F). The gas bubble still appears to be present at a much reduced volume, with bubble size calculations still being evaluated. Degasification continues. Containment atmosphere measurements indicate about 1.9 percent hydrogen. One hydrogen recombiner is operating, and a 12 day time period is projected for reduction of the hydrogen concentration to about 1%.

Plans to use a robot device to obtain a primary coolant sample are being evaluated. Preoperational testing with the robot is in progress.

Environmental Status

No surveillance flights have been conducted since 6:00 AM on April 2 because of weather. All offsite ground surveys indicate about 0.02 millirem/hour, except for a brief period during periodic venting of the Primary System Makeup Tank to the vent header. During this venting, an offsite team detected a brief, downwind 1.5 millirentgen/hour ground level dose rate with a rapid return to 0.02 millirentgen/hour. This level is less than others reported previously for similar operational activities.

Dose rates in populated areas as measured by NRC thermoluminescent dosimeters (TLD) showed a decrease from the previous day. Following are the data for the first two days.

CONTINUED

Dose Rate (Milliroentgens per Hour)

	<u>4/1/79</u>	<u>4/2/79</u>
Falmouth	No Sample	0.01
Middletown	0.044	0.01
Goldsboro	0.13	0.05
Goldsboro	0.040	0.02
Lewisberry	0.053	0.02
Pleasant Grove	0.041	0.02
York Haven	0.074	0.02
Conewago Heights	0.044	0.02
Emigeville	0.053	0.02

On April 2, the Food and Drug Administration reported concentrations of radioiodine in eight milk samples. The results ranged from 10 picocuries per liter (the minimum detectable activity) to 20 ± 10 picocuries per liter.

Since March 30, there have been controlled releases of several hundred thousand gallons of water from the industrial waste tank to the Susquehanna River. The effluents contain radioiodine. On April 2, the FDA reported that a sample of river water collected two miles from the plant was analyzed and found to contain 3.9×10^{-8} microcuries per milliliter of iodine-131, or about 13% of maximum permissible concentration (MPC).

Other Information

Exposure data collected at 1:00 am on April 3 indicated a level of <0.1 mR/hr in the Unit 2 control room compared to a level of 0.4 mR/hr measured early on April 2. On April 3, the auxiliary building access corridor showed 0.05 mR/hr and the personnel access hatch to the reactor building indicated 4 mR/hr.

Analysis of a second sample of containment building gas showed a decrease from concentrations determined as of March 31. Following are the data for the two analyses:

Concentration in Microcuries per Milliliter

<u>Isotope</u>	<u>3/31/79 at 7:00 am</u>	<u>4/2/79 at 10:30 am</u>
Xe 133	676	65
Xe 133m	16	0.27
Xe 135	8.1	0.62
I 131	0.063	0.0097
I 133	<0.03	<0.0061

CONTINUED

Contact: DThompson, IE x28487 NCMoseley, IE x28160

Distribution: Transmitted H St 5:20

Chairman Hendrie
Commissioner Kennedy
Commissioner Gilinsky

Commissioner Bradford
Commissioner Ahearne

S. J. Chilk, SECY
C. C. Kammerer, CA
(For Distribution)

Transmitted: MNBB 5:21

L. V. Gossick, EDO
H. L. Ornstein, EDO
J. J. Fouchard, PA
N. M. Haller, MPA
R. G. Ryan, OSP
H. K. Shapar, ELD

P. Bldg ~~535~~ 530
H. R. Denton, NRR
R. C. DeYoung, NRR
R. J. Mattson, NRR
V. Stello, NRR
R. S. Boyd, NRR
SS Bldg 536
W. J. Dircks, NMSS

J. G. Davis, IE
Region I 5:35
Region II 5:35
Region III 5:35
Region IV 5:35
Region V 5:35
(MAIL)
J. J. Cummings, OIA
R. Minogue, SD

White House Situation Room _____

(Handcarry _____)

EPA 0:50
FDA/BRH 6:50
DOE/EOC 6:40
FAA _____
FDAA 7:10

DCDA 7:33
BRD 8:20

IMMEDIATE

PRELIMINARY NOTIFICATION

IMMEDIATE
PRELIMINARY NOTIFICATION

April 4, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67J

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 am on 4/4/79.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

The cooling path to remove core decay heat continues to be through "A" steam generator to the main condenser.

Reactor pressure remains near 1000 psi, with bulk core coolant inlet and outlet temperatures at 280 degrees F. Core thermocouple readings are relatively unchanged and indicate a maximum temperature of 466 degrees F which is well below saturation temperature for this pressure. (Only three thermocouples read above 400 degrees F.) Gas is still indicated to be present based on bubble size calculations, but its volume is erratic indicating the effects of solubility and bubble dispersion. Vent valve on pressurizer has been closed and degasification continues through the letdown system.

Containment atmosphere measurements indicate about 2.1% hydrogen. One hydrogen recombiner is operating and an 11-day time period is projected for reduction of the hydrogen concentration to about 1%. At 1430 on April 3, one of three pressurizer level transmitters failed. Alternate methods of level measurements are being developed and procedures reviewed for implementation while calibration can occur with the existing detectors.

Plans to use a robot device to obtain a primary coolant sample are being evaluated. Preop testing with the robot is in progress.

The containment building, April 3, 1979, gas sample results reported on page 2 of PNO-79-67I have been determined to be incorrect and should be disregarded.

CONTINUED

Environmental Status

FDA has reanalyzed the river water sample collected the afternoon of April 2, 1979 at a location 2 miles downstream. The value of 39 picocuries per liter iodine-131 previously reported for this sample (PN-79-67I) has been found to be incorrect; no iodine above minimum detectable levels has been found.

ARMS flights were conducted at 9:00 am and 12:00 noon on April 3, 1979. The maximum radiation levels were detected during the 12:00 noon flight during which a maximum level of 2.0 mR/hr was measured at 1 mile from the plant; the level at 3 miles was 1.2 mR/hr. At a distance of 1 mile the plume was 1 mile wide with centerline about 290°.

Two other flights were conducted at 12:30 a.m. and 3:00 a.m. on April 4. The earlier flight measured radiation levels of 0.3 mR/hr at 1 mile and 0.1 to 0.2 mR/hr at 3 miles at altitudes of 600-700 feet. The plume was 0.3 mile wide at one mile centered at about 210°. Past 3 miles the plume was undefined and radiation levels were about 0.05 mR/hr. The later flight measured radiation levels of 1.1 mR/hr at 1 mile, 0.5 mR/hr at 3 miles and 0.3 mR/hr at 6 miles, at an altitude of about 500 feet. The plume was 0.6 mile wide at a distance of 1 mile from the plant, centered at 235°.

Offsite ground surveys indicated about 0.5 mR/hr for a brief period on the east side of the site. Radiation levels generally ranged from 0.01 to 0.02 mR/hr around the site.

An air sample for iodine-131 was collected in the plume at a location about 0.8 mile SSE of the plant. The iodine concentration in air was less than 1×10^{-10} microcuries per cubic centimeter.

Dose rates in populated areas as measured by NRC thermoluminescent dosimeters (TLDs) showed a slight increase from the previous day. The highest exposure rate was 0.41 mR/hr at a location 1 mile SSE of the plant. Following are the exposure rates for previously reported locations:

	<u>4/1/79</u>	<u>4/2/79</u>	<u>4/3/79</u>
Falmouth	0.15	0.01	.20
Middletown	0.044	0.01	.02
Goldsboro	0.13	0.05	.07
Goldsboro	0.040	0.02	.05
Lewisberry	0.053	0.02	.04
Pleasant Grove	0.041	0.02	.06
York Haven	0.074	0.02	.10
Conewago Heights	0.044	0.02	.07
Emigsville	0.053	0.02	.07

CONTINUED

Summary of Environmental Monitoring

Data concerning iodine released to the environment has been gathered and evaluated by the NRC, other Federal agencies, the State of Pennsylvania, and by the licensee. Several of the monitoring programs have been ongoing almost since the outset of the incident which began early on 3/28/79.

This information is based on data available to NRC as of 0630, April 3, 1979.

Water

A total of 130 offsite water samples were analyzed by NRC, DOE, and the Commonwealth of Pennsylvania. None of the 130 have shown any detectable radioiodine.

Based on calculations of the radioiodine released from the station to the river, it is estimated that the thyroid dose to any individual drinking the water is less than 0.2 mrem.

Air

152 offsite air samples were taken during the period 3/28-4/2 and analyzed by NRC, DOE, the Commonwealth of Pennsylvania, and by the licensee at distances up to 40 miles from Three Mile Island. The radioactivity in air which has been measured is principally noble gases--xenon isotopes. Eight of the 152 samples have indicated concentrations of radioiodine ranging from 2.7×10^{-13} - 2.4×10^{-11} microcuries/cc. No radioiodine was detected in the other samples. The maximum activity detected is about one-fourth of the permissible concentration established in the NRC "Standards for Protection Against Radiation," in Title 10, Code of Federal Regulations, Part 20 (10 CFR 20).

Based on calculations of the radioiodines released from the station to the atmosphere, it is estimated that the thyroid dose to an individual at the site boundary is less than 50 mrem over a 5-day period.

Milk

A total of 56 samples were collected from about 20 farms, located up to 13 miles in all directions from Three Mile Island. Of these, 38 showed no detectable radioiodine and 18 were reported as "no data." These analyses were conducted by the Commonwealth of Pennsylvania.

FDA has conducted an analysis of 9 milk samples collected April 1, 1979 and reported "positive" results ranging from 14 to 40 picocuries

CONTINUED

of I-131 per liter of milk. A sample of goat's milk, collected on March 30, 1979, contained 41 picocuries per liter. By comparison, the U.S. Department of Health, Education and Welfare recommends placing dairy herds on stored feed when I-131 in milk reaches 12,000 pCi/liter. Local herds are on stored feed because this is not the pasture season.

Based on measurements of the maximum concentration of radioiodine in all milk samples, the thyroid dose to any individual drinking milk is less than 0.5 mrem/day.

Vegetation

One hundred seventy-one vegetation samples have been collected and analyzed by DOE, NRC, and the Commonwealth of Pennsylvania. None showed any detectable radioiodine. These samples were taken at various locations within 2 miles of the site.

Soil

One hundred forty-seven soil samples were collected and analyzed by NRC and DOE. None showed any detectable radioiodine.

Inventory of Iodine in Plant

The greatest quantity of iodine in the plant is contained in the core and the coolant. The following table shows the inventory as of 0001 on 4/3/79.

	<u>Core*</u>	<u>Coolant**</u>
I-131	49 x 10 ⁶ Ci	3.2 x 10 ⁶ Ci
I-133	2.1 x 10 ⁶ Ci	0.12 x 10 ⁶ Ci

*Based on computer projections of Penn State University

**Based on primary coolant analysis decayed to the above date and time

A small source of iodine is from the industrial waste treatment system (IWTS) which presently contains 272,000 gallons of water having an iodine content as follows:

I-131	0.234 Ci
I-133	<u>0.00087 Ci</u>
TOTAL	0.23487 Ci

As of 2400 on 4/2/79, there were approximately 240,000 gallons of liquid in the IWTS with approximately 280,000 gallons of available storage

CONTINUED

space. Currently, the turbine building sump is filling at a rate of approximately 30 gpm; however, over the last 3-day period the liquid has accumulated in the system at an average rate of 143 gpm. At the later accumulation rate, the IWTS would overflow at approximately 11:00 am on April 4, 1979 unless other action is taken. Efforts are underway by the licensee to obtain state approval for discharge.

The maximum concentration of radioiodine in the IWTS was 1.5×10^{-3} $\mu\text{Ci/ml}$ at 1000, March 31, 1979. That value has steadily decreased since that time. As of 1600, April 2, 1979, radioiodine concentration in the IWTS was 4.2×10^{-5} $\mu\text{Ci/ml}$ which, when diluted in the plant discharge water, would be about 1/3 off the technical specification limit of 3×10^{-7} microcuries per milliliter at the plant discharge.

Other Information

The attached table of collective doses was prepared by a joint NRC/HEW/EPA study group.

Contact: DThompson, IE x28487 NCMoseley, IE x28160

Distribution: Transmitted H St 8:18 AM
Chairman Hendrie Commissioner Bradford
Commissioner Kennedy Commissioner Ahearne
Commissioner Gilinsky

S. J. Chilk, SECY
C. C. Kammerer, CA
(For Distribution)

Transmitted: MNBB 8:39
L. V. Gossick, EDO
H. L. Ornstein, EDO
J. J. Fouchard, PA
N. M. Haller, MPA
R. G. Ryan, OSP
H. K. Shapar, ELD
P. Bldg 9:00
H. R. Denton, NRR
R. C. DeYoung, NRR
R. J. Mattson, NRR
V. Stello, NRR
R. S. Boyd, NRR
SS Bldg 8:30
W. J. Dircks, NMSS

J. G. Davis, IE
Region I
Region II
Region III } 8:45
Region IV
Region V
(MAIL)
J. J. Cummings, OIA
R. Minogue, SD

White House Situation Room 10:20
(Handcarry)
EPA 11:20 AM
FDA/BRH 12:10 PM
DOE/EOC 12:30 PM
FAA HANDCARRY
FDAA 12:10 PM
BRP 12:50 PM
DCPA 1:00 PM

IMMEDIATE

PRELIMINARY NOTIFICATION

COMPARISON OF COLLECTIVE DOSES TO POPULATION
 WITHIN 50 MILES OF THREE MILE ISLAND
 NUCLEAR GENERATING STATION

Source	Whole-Body Collective Dose (man-rem)	Average Dose to Individual (mrem/year)
Natural Background		
One year's exposure (FES) (1970 population)	233,000	125
(1980 population)	270,700	
Normal Operation (FES) (1970 population)		
One year's exposure (all sources)	31	0.017
Gaseous effluents	2.05	0.0011
30-year operation	930	0.017
Preliminary Estimate of Accident Dose		
Cumulative up to noon 4/2/79	1,800	0.83
1970 population	1,868,000	
1980 census projections	2,165,651	

Note: 1 mrem (millirem) = 0.001 rem

FES = Final Environmental Statement

IMMEDIATE

PRELIMINARY NOTIFICATION

April 5, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67K

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 am on 4/5/79.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

Reactor pressure remains near 1000 psi with bulk core coolant inlet and outlet temperatures approximately 280 degrees F. Core thermocouple readings are relatively unchanged and indicate a maximum temperature of 462 degrees F which is well below saturation temperature for the present reactor pressure. Three thermocouple readings remain above 400 degrees F. The number of thermocouple readings that are being monitored has been reduced to 30.

Containment atmosphere measurements indicate about 2% hydrogen. One hydrogen recombiner is in operation, with another unit on standby.

A Heise pressure gauge has been installed to provide an alternate method of determining the pressurizer level by monitoring the steam space pressure and water space pressure in the pressurizer. Testing procedures are under review. The pressurizer is being vented to the containment for about 15 minutes every 6-8 hours.

Plans for use of the robot to obtain a primary system sample have been developed.

Environmental Status

Preliminary analysis by FDA of 16 milk and miscellaneous food products collected on April 3, 1979 showed no detectable iodine concentrations in 12 samples and iodine ranging from 12-18 pCi/l in 4 milk samples. The State of Maryland reported on April 4, 1979 the results of analysis of 12 milk samples collected from 3 to 20 miles from the site. All samples were reported as less than the minimum detectable activity (MDA). One process milk sample from Harrisburg also was reported by the State of Maryland as less than MDA. Three water samples, two at Conewago and one from Holtwood Dam, were reported as less than MDA by the State of Maryland.

CONTINUED

FDA collected 5 other milk samples on April 3, 1979, two of which showed iodine concentrations of 12 and 17 pCi/l. One showed no detectable iodine and there are no results for the other two samples. One of these samples showed a cesium concentration of 13 pCi/l; there are no cesium results for the other four. The State of Pennsylvania analysis of 15 milk samples collected on April 3, 1979 showed one with iodine at 19 pCi/l, 13 with no detectable iodine, and 1 with no result. Four showed cesium levels ranging from 10-26 pCi/l and there are no results for the other 11 samples. All of the samples collected by the State and FDA were split samples, i.e., shared to obtain independent results.

Continuous ground level radiation surveys performed on April 4, 1979 by the NRC survey teams on the east and west sides of the Susquehanna River from a distance of 4 miles north to 4 miles south of TMI showed radiation levels averaging less than 0.03 mR/hr on the east side of the river and 0.01 to 0.04 mR/hr on the west side of the river. Prevalent wind direction during the day was from the east.

Six ARMS surveys were performed on April 4, 1979 at: 0001, 0300, 0600, 0900, 1200 and 1522 hours. The flights identified the plume to be in the sections of 200° and 300°. The maximum radiation levels were detected during the 0600 flight during which levels of 1.2 mR/hr were detected using portable survey meters. The 1522 flight used normally installed ARMS instrumentation and measured radiation levels of about 0.1 mR/hr (about 5 times background) at 1 mile distance and about 0.06 mR/hr (about 3 times background) at 2 miles distance.

On April 4, a 40-minute air sample taken about 0100 near York Haven, and a 60-minute sample taken about 1300 in Goldsboro, both indicated less than 1×10^{-10} $\mu\text{Ci/ml}$ I-131 (maximum permissible concentration for unrestricted areas).

Dose rates in populated areas as measured by NRC thermoluminescent dosimeters (TLDs) showed only minor changes from the previous day. Minor fluctuations are expected at these low dose rates. Following are the exposure rates for previously reported locations:

Dose Rate (Milliroentgens per Hour)

	<u>4/1/79</u>	<u>4/2/79</u>	<u>4/3/79</u>	<u>4/4/79</u>
Falmouth	0.15	0.01	0.20	0.04
Middletown	0.04	0.01	0.02	0.01
Goldsboro	0.13	0.05	0.07	0.07
Goldsboro	0.04	0.02	0.05	0.02
Lewisberry	0.05	0.02	0.04	0.03
Pleasant Grove	0.04	0.02	0.06	0.01
York Haven	0.07	0.02	0.10	0.05
Conewago Heights	0.04	0.02	0.07	0.02
Emigsville	0.05	0.02	0.07	0.02

CONTINUED

Occupational Radiation Exposures

Three occupational radiation doses in excess of the regulatory limit of 3 rems per calendar quarter have been confirmed. All three exposures were licensee personnel and were approximately 4 rems (this includes the two exposures reported in PNO-79-67B).

To date on April 4, 1979, there have been 12 individuals with doses greater than 2 rems but less than 3 rems. Three doses are for the period January 1 to April 4, 1979, but it is believed the majority of exposure was received as a result of the incident. More specific occupational exposure data is expected to be available in the near future.

Industrial Waste Treatment System (IWTS)

As of 0500 on April 5, 1979, the IWTS sump was 74% filled with about 100,000 gallons of capacity still available. The State of Pennsylvania approved release of material from the IWTS that does not exceed permissible values. No releases have been made as of 0500.

Other Information

At about 5:00 pm on April 4, 1979, the licensee initiated the shipment of solidified low level waste which was collected from Unit 1 prior to the Unit 2 event of March 28, 1979. Additional shipments will be made twice daily. The waste is being sent to the Chem Nuclear facility in South Carolina.

The attached table of collective doses updated to April 3 was prepared by a joint NRC/HEW/EPA study group.

Contact: DThompson, IE x28487 NCMoseley, IE x28160

Distribution: Transmitted H St 8:40
Chairman Hendrie Commissioner Bradford S. J. Chilk, SECY
Commissioner Kennedy Commissioner Ahearne C. C. Kammerer, CA
Commissioner Gilinsky (For Distribution)

Transmitted: MNBB 8:47 P. Bldg 8:52 J. G. Davis, IE
L. V. Gossick, EDO H. R. Denton, NRR Region I
H. L. Ornstein, EDO R. C. DeYoung, NRR Region II
J. J. Fouchard, PA R. J. Mattson, NRR Region III } 9:05
N. M. Haller, MPA V. Stello, NRR Region IV
R. G. Ryan, OSP R. S. Boyd, NRR Region V
H. K. Shapar, ELD SS Bldg 8:52 (MAIL)
W. J. Dircks, NMSS J. J. Cummings, OIA
Saul Levin, RES R. Minogue, SD

Distribution:
IE (TMI) Site: 8:45 (Provide copy to STATE)
White House Situation Room 9:50
EPA 11:00
FDA/BRH 11:30
DOE/EOC 9:35
FDDA/FEMA 11:56
BRP (State of PA) 12:02
DCPA 12:20
HEW _____

Handcarry (FAA)

IMMEDIATE

PRELIMINARY NOTIFICATION

COMPARISON OF COLLECTIVE DOSES TO POPULATION
 WITHIN 50 MILES OF THREE MILE ISLAND
 NUCLEAR GENERATING STATION

Source	Whole-Body Collective Dose (man-rem)	Average Dose to Individual (mrem/year)
Natural Background		
One year's exposure (FES) (1970 population)	233,000	125
(1980 population)	270,700	
Normal Operation (FES) (1970 population)		
One year's exposure (all sources)	31	0.017
Gaseous effluents	2.05	0.0011
30-year operation	930	0.017
Preliminary Estimate of Accident Dose		
Cumulative up to noon 4/3/79	2000	1.0
1970 population	1,868,000	
1980 census projections	2,165,651	

Note: 1 mrem (millirem) = 0.001 rem
 FES = Final Environmental Statement

IMMEDIATE
PRELIMINARY NOTIFICATION

April 6, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67L

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented in a summary of information as of 7:00 a.m. on 4/6/79.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

Reactor pressure is about 1075 psi with bulk core coolant inlet and outlet temperatures at about 285 degrees F. Core thermocouple readings are relatively unchanged and indicate a maximum temperature of 448 degrees F, well below saturation temperature for the present reactor pressure. Three thermocouple readings remain above 400 degrees F. Thirty thermocouples are being monitored.

Containment atmosphere measurements indicate less than 2% hydrogen. One hydrogen recombiner is in operation, with the second unit on standby.

A Heise pressure gauge, installed to provide an alternate method of monitoring pressurizer level, has been unsatisfactorily pressure tested. (Boron crystals indicate leakage from an elbow in the bypass line around the sample cooler.)

Plans to vent Make-Up Tank (MUT) and one of the Waste Gas Decay Tanks (WGDT) gases to containment have been approved by the NRC. Waste Gas Decay Tank "A" venting to the containment was started at approximately 0545 on April 6, 1979. Venting was terminated at 0630 following an approximately ten-fold increase in radiation levels detected by the auxiliary building exhaust monitor.

Environmental Status

Periodic ground level radiation surveys performed on April 5, 1979 by the NRC survey teams on the east and west sides of the Susquehanna River from a distance of 4 miles north to 4 miles south of TMI detected radiation levels averaging less than 0.01 mR/hr on the west side and from 0.01 to 0.15 mR/hr on the east side. Prevalent wind direction during the day was from the west-northwest.

ARMS surveys were performed on April 5, 1979 at 0600, 0950, 1430, 1515, 1649, and 2120 hours. The flights identified the plume in the sector 110° to 130°. The maximum radiation levels were detected during the 0950 flight during which levels of 0.3 mR/hr were measured at 1 mile. Between 3 and 10 miles, the measured levels were from 0.03 to 0.05 mR/hr.

The State of Pennsylvania reported data on milk, water, precipitation and grass samples. Analysis of ten milk samples collected on April 4 and 5 detected no radioiodine above the minimum detectable activity (MDA). Also, the results of analysis of water samples collected from five cities surrounding TMI from March 31, 1979 to April 4, 1979 detected no levels of iodine above the MDA, as did analysis of precipitation and grass samples for April 2 and 4.

Dose rates in populated areas as measured by NRC thermoluminescent dosimeters (TLDs) showed only minor changes from the previous day. Minor fluctuations are expected at these low dose rates. Ten additional TLD stations at area schools were established on April 5 (making a total of 47 stations). Following are the exposure rates for previously reported locations:

Dose Rate (Milliroentgens per Hour)

	<u>4/1/79</u>	<u>4/2/79</u>	<u>4/3/79</u>	<u>4/4/79</u>	<u>4/5/79</u>
Falmouth	0.15	0.01	0.20	0.04	0.02
Middletown	0.04	0.01	0.02	0.01	0.01
Goldsboro	0.13	0.05	0.07	0.07	0.05
Goldsboro	0.04	0.02	0.05	0.02	0.03
Lewisberry	0.05	0.02	0.04	0.03	0.02
Pleasant Grove	0.04	0.02	0.06	0.01	0.01
York Haven	0.07	0.02	0.10	0.05	0.01
Conewago Heights	0.04	0.02	0.07	0.02	0.01
Emigsville	0.05	0.02	0.07	0.02	0.02

Population Exposure Estimates

Representatives from NRC, EPA and HEW have made estimates of the radiation doses to the public around TMI based primarily on TLD data. The calculated population dose increment for 4/3/79 to 4/4/79 is 70 man-rems. The total cumulative, 50 mile radius population dose since 3/28/79 is estimated to be 2100 man-rems with an average dose to an individual of 1.1 millirems. The estimated maximum dose to an individual offsite (hypothetical, continuously present 0.5 mile NE of plant) is estimated to be less than 100 millirem.

Industrial Waste Treatment System (IWTS)

Industrial waste discharge (other than sewage) began about 3 a.m., 4/6/79 at an average rate of 100 gpm with Iodine 131 radioactivity of 2.3×10^{-5} microcuries per milliliter into the 58,000 gpm cooling tower discharge to the river. The Unit 1 waste evaporator condensate storage tank is also being discharged. The licensee has calculated the release to the river to be about two-thirds the MPC for continuous discharge of Iodine 131 from both units. The discharge from the Unit 2 Industrial Waste Treatment System was stopped at approximately 0400 on 4/6/79 to collect and analyze a sample.

Other Information

IE Bulletin 79-05A was issued on April 5, 1979 and required additional actions by Babcock and Wilcox power reactor facilities with a operating license.

Contact:

Distribution:	Transmitted H St <u>12:00 P.</u>	
Chairman Hendrie	Commissioner Bradford	S. J. Chilk, SECY
Commissioner Kennedy	Commissioner Ahearne	C. C. Kammerer, CA
Commissioner Gilinsky		(For Distribution)
Transmitted: MNBB <u>12:10p.</u>	P. Bldg <u>12:44</u> <u>12:15</u>	J. G. Davis, IE
L. V. Gossick, EDO	H. R. Denton, NRR	Region I <u>1:05</u>
H. L. Ornstein, EDO	R. C. DeYoung, NRR	Region II <u>10:10</u>
J. J. Fouchard, PA	R. J. Mattson, NRR	Region III <u>1:10</u>
N. M. Haller, MPA	V. Stello, NRR	Region IV <u>1:15</u>
R. G. Ryan, OSP	R. S. Boyd, NRR	Region V <u>1:20</u>
H. K. Shapar, ELD	SS Bldg <u>12:55</u>	(MAIL)
	W. J. Dircks, NMSS	J. J. Cummings, OIA
	S. Levine, RES	R. Minogue, SD

IE (TMI) Site 11:30p.m. (Provide copy to STATE)
 White House Situation Room 1:55
 EPA 2:15
 FDA/BRH 2:16
 DOE/EOC 2:40
 FDDA/FEMA 2:16
 BRP (State of PA) 2:50
 DCPA 3:00
 HEW (Picked Up)

Handcarry (FAA)

IMMEDIATE

PRELIMINARY NOTIFICATION

IMMEDIATE

PRELIMINARY NOTIFICATION

April 7, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67M

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on 4/7/79.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status:

The reactor pressure is about 1075 psi with bulk core coolant inlet and outlet temperatures at about 285° F. At approximately 1:25 p.m. on April 6, reactor coolant pump 1A tripped and reactor coolant pump 2A was started within about two minutes. After the change in operating pumps, there was a shift in the core thermocouple readings. The three thermocouples that had readings above 400° F are presently reading between 285° F and 315° F. The central thermocouple (position 8H) reading changed from approximately 375° F to 455° F and is now reading 453° F, the only reading above 400° F. The average temperature of the 30 thermocouples being monitored is 304° F.

The venting of Waste Gas Decay Tanks (WGDT) "A" and "B" to the containment building was resumed at 9:15 a.m. on April 6, 1979 and stopped at about 3:00 a.m. on April 7 when the pressures of WGDT "A" and "B" were 32 and 30 psig, respectively. At the time the venting was secured, a small release occurred resulting in radiation readings somewhat lower than previously experienced during such operations. Following venting of the WGDT to containment, the hydrogen concentration in the containment was slightly greater than 2%.

The discharge to the river from the industrial waste storage tanks (IWST) was resumed at 6:15 a.m. on April 6, 1979 at an average rate of 100 gpm. The IWST level is now about 52%.

Environmental Status:

Off-site radiation levels as identified by NRC survey teams continue to range between 0.01 and 0.1 mr/hr. These routine survey results were obtained on the east and west sides of the Susquehanna River at distances of four miles north and south of TMI. Prevailing winds during April 6 were from 270° to 300° (SSE).

CONTINUED

ARMS surveys were performed at 0700 and 1810 on April 6, 1979. The surveys identified a plume in the 120°-140° sector during both flights. The maximum radiation level identified during the 0700 survey was 0.3 mr/hr one mile from the site at 900 feet elevation. The 1810 flight identified 0.05 mr/hr three miles from the site at 500 feet elevation.

The State of Pennsylvania reported an iodine 131 level of 12 picocuries per liter (pCi/l) for one milk sample collected on April 5, 1979. Pennsylvania's minimum detectable activity (MDA) for this type of measurement is 10 pCi/l. The State of Maryland reported iodine 131 levels less than MDA (10 pCi/l) for one sample collected on April 4, 1979 and a second collected on April 5, 1979.

Airborne concentrations for 34 EPA samples collected between April 4, 1979 and April 5 were reported as at or less than MDA (1.8×10^{-13} microcuries per milliliter).

No new data regarding vegetation and water samples have been reported.

Dose rates in populated areas as measured by NRC thermoluminescent dosimeters (TLDs) showed only minor changes from the previous day. Minor fluctuations are expected at these low dose rates. Ten additional TLD stations at area schools were established on April 5 (making a total of 47 stations). Following are the radiation dose rates for previously reported locations:

Dose Rate (Milliroentgens per Hour)

	<u>4/1/79</u>	<u>4/2/79</u>	<u>4/3/79</u>	<u>4/4/79</u>	<u>4/5/79</u>	<u>4/6/79</u>
Falmouth	0.15	0.01	0.20	0.04	0.02	0.02
Middletown	0.04	0.01	0.02	0.01	0.01	0.01
Goldsboro	0.13	0.05	0.07	0.07	0.05	0.03
Goldsboro - South	0.04	0.02	0.05	0.02	0.03	0.02
Lewisberry	0.05	0.02	0.04	0.03	0.02	0.02
Pleasant Grove	0.04	0.02	0.06	0.01	0.01	0.02
York Haven	0.07	0.02	0.10	0.05	0.01	0.02
Conewago Heights	0.04	0.02	0.07	0.02	0.01	0.02
Emigsville	0.05	0.02	0.07	0.02	0.02	0.02

Contact: DThompson, IE x28487 NCMoseley, IE x28160

CONTINUED

Distribution: Transmitted H St 9:50
Chairman Hendrie
Commissioner Kennedy
Commissioner Gilinsky

Commissioner Bradford
Commissioner Ahearne

S. J. Chilk, SECY
C. C. Kammerer, CA
(For Distribution)

Transmitted: MNBB 9:55
L. V. Gossick, EDO
H. L. Ornstein, EDO
J. J. Fouchard, PA
N. M. Haller, MPA
R. G. Ryan, OSP
H. K. Shapar, ELD

P. Bldg 9:57
H. R. Denton, NRR
R. C. DeYoung, NRR
R. J. Mattson, NRR
V. Stello, NRR
R. S. Boyd, NRR
SS Bldg 9:59
W. J. Dircks, NMSS
Saul Levine, RES

J. G. Davis, IE
Region I 10:00
Region II 10:19
Region III 11:10
Region IV 10:13
Region V 10:23
(MAIL)
J. J. Cummings, OIA
R. Minogue, SD

Distribution:
IE (TMI) Site: 10:30 (Provide copy to STATE)
White House Situation Room 10:33
EPA 11:13
FDA/BRH 11:30
DOE/EOC 11:40
FDDA/FEMA 11:30
BRP (State of PA) 11:45
DCPA 12:10
HEW _____

Handcarry (FAA)

IMMEDIATE

PRELIMINARY NOTIFICATION

IMMEDIATE
PRELIMINARY NOTIFICATION

April 8, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67N

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on 4/8/79.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

Bulk coolant inlet and outlet temperatures are about 281 degrees F. The average core thermocouple temperature is about 299 degrees F, and the higher thermocouple reading (8H) is about 442 degrees F.

At approximately 1955 hours, April 7, the licensee began lowering reactor coolant system pressure in 50 psi increments at a maximum rate of 5 psi per minute. This will continue until pressure reaches 500 psi, providing a 100 psi safety margin above saturation for the current temperature of the highest reading thermocouple. This is a step toward cold shutdown and includes degasification to prevent bubble formation as pressure and temperatures decrease.

During the initial pressure decrease to 700 psi, the auxiliary building stack monitors showed an increase of a factor of 10 at 2213 hours, April 7. Later information indicates that about 1400 gallons of borated water were added to the makeup tank during the initial pressure reduction, causing some gas to leak from the vent header. The ARMS helicopter reported a slight increase in readings downwind (south) of the site. Pressure was held steady for a short period and the auxiliary stack monitors decreased to the original readings. During the following pressure cycles there have been no increases in the radiation readings.

Hydrogen concentration in containment is about 1.9%.

At 2130 hours PST, April 7, airlifting of backup charcoal filters for the auxiliary building stack was initiated from Pasco, WA, to Harrisburg, PA.

The Unit 2 miscellaneous waste tank is being pumped to a bleed holdup tank in preparation for pumping the auxiliary building sump dry. IWTS discharge was stopped late on April 7 when the level reached 32%.

CONTINUED

Environmental Status

Offsite radiation levels identified by NRC survey teams continue to range between 0.01-0.1 mR/hr. These routine survey results were obtained on the east and west sides of the Susquehanna River at distances of 4 miles north and south of the site. Prevailing winds during April 7 were generally from about 320°.

ARMS surveys were performed on April 7 at 0600-0630 hours and 1800-1845 hours. The surveys identified a narrow plume in the 140°-150° sector during both flights. A maximum radiation level of 0.04 mR/hr at 1-10 miles was identified during the 0600-0630 hours flight. The 1800-1845 hours flight identified a maximum reading of 0.05 mR/hr at 1 mile from the site.

The following milk sample results were reported by the licensee.

<u>Location</u>	<u>Iodine Concentration (picocuries/liter)*</u>					
	<u>3/29</u>	<u>3/30</u>	<u>3/31</u>	<u>4/1</u>	<u>4/2</u>	<u>4/3</u>
1.1 miles east-northeast	< 1		8.5	4.5	3	1
1.6 miles southeast	< 1	-	21	-	4	2
2.7 miles west-northwest	< 3	-	4	-	3	2
control 12 miles north-northeast	< 1	-	< 1	< 1	< 1	< 1

*HEW Action Level: 12,000 picocuries/liter

The following table lists the composite results for milk samples collected by various agencies between 3/28/79 - 4/4/79.

<u>Description</u>	<u>STATE</u>	<u>FDA</u>	<u>EPA</u>
Number of analyses performed	133	84	4
Number of positive results	7	53	2
Average value of positive results (pCi/l)	15	19	17
Range of positive results (pCi/l)	11-20	9-41	10-24
Average MDA (pCi/l)	20	11	10

The following iodine-131 concentrations in air and water were identified by the licensee:

a. <u>Air Samples</u>		<u>Results (picocuries per cubic meter)**</u>		
<u>Location</u>		<u>3/28-3/29</u>	<u>3/29-3/31</u>	<u>3/31-4/3</u>
0.4 mile north		0.47	22.6	0.11
2.3 miles south-southeast		< 0.2	22.1	1.39
0.4 " east		< 0.02	20.3	0.27
15 " northwest		< 0.03	1.83	< 0.024
9 " southeast		< 0.04	0.27	0.16
2.6 " north		0.08	12.7	0.051
1.6 " west-southwest		< 0.30	23.9	0.07
13 " south		< 0.02	0.14	0.36

**10 CFR 20 MPC: 100 picocuries/cubic meter

b. <u>Water Samples</u>		<u>Collected on 4/3/79</u>	<u>Results***</u>
<u>Location</u>			
Swatara Creek (2.3 miles north)			< 0.2 pCi/l
Brunner Island (4.1 miles south-southeast)			"
Columbia water treatment plant (15 miles southeast)			"
York Haven (3 miles southeast)			"
York (15 miles southeast)			"

***10 CFR 20 MPC: 100 picocuries/liter

New data regarding dose rates in populated areas have not been processed.

Contact:

<u>Distribution:</u>	Transmitted H St <u>7:50</u>	
Chairman Hendrie	Commissioner Bradford	S. J. Chilk, SECY
Commissioner Kennedy	Commissioner Ahearne	C. C. Kammerer, CA
Commissioner Gilinsky		(For Distribution)
Transmitted: MNBB <u>7:52</u>	P. Bldg <u>7:55</u>	J. G. Davis, IE
L. V. Gossick, EDO	H. R. Denton, NRR	Region I <u>8:02</u>
H. L. Ornstein, EDO	R. C. DeYoung, NRR	Region II <u>8:05</u>
J. J. Fouchard, PA	R. J. Mattson, NRR	Region III <u>8:08</u>
N. M. Haller, MPA	V. Stello, NRR	Region IV <u>8:15</u>
R. G. Ryan, OSP	R. S. Boyd, NBR	Region V <u>8:17</u>
H. K. Shapar, ELD	SS Bldg <u>7:58</u>	(MAIL)
	W. J. Dircks, NMSS	J. J. Cummings, OIA
	S. Levine, RES	R. Minogue, SD

IE (TMI) Site 8:22 (Provide copy to STATE)
White House Situation Room 9:30
EPA 9:25
FDA/BRH 9:18
DOE/EOC 8:35
FDDA/FEMA 9:18
BRP (State of PA) 10:30
DCPA 10:45
HEW _____

Handcarry (FAA)

IMMEDIATE
PRELIMINARY NOTIFICATION

(CORRECTED COPY)
IMMEDIATE
PRELIMINARY NOTIFICATION

April 9, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67P*

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 6:00 a.m. on 4/9/79.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

Bulk coolant inlet and outlet temperatures are about 280 degrees F. The average core thermocouple temperature is about 300 degrees F, and the highest thermocouple reading (8H) is about 425 degrees F.

At approximately 0430 hours, April 9, the reactor coolant system pressure reached the 400 psig endpoint established for the second degassing evolution. At lower pressures in the 400 to 1,000 psig range, noise monitoring indicated possible presence of some gas in Loop B of the reactor cooling system. Noise monitoring verified re-resolution of gas with time. The operating reactor coolant pump vibration increased to 8.5-9 mils but the level of vibration was still significantly below the limit (30 mils). Pressure variation for degassing is continuing. Following reduction to 400 psig, the licensee plans to increase pressure to the 900-1,000 psig range and a phased cooldown is under consideration as the next step.

The licensee requested and received permission to temporarily change the minimum pressurizer level to 150" from 200" to prevent high pressurizer levels on pressure decreases.

At approximately 1320 hours, April 8, the reactor coolant system began to heat up. This was due to a decrease in steam generator level. Steam Generator A level was increased to decrease the primary temperature.

Hydrogen concentration in containment is about 1.85%.

At approximately 1942 hours EST, the last airplane involved in the filter airlift left Pasco, WA, for Harrisburg, PA.

CONTINUED (CORRECTED COPY)

* (The letter "O" was not used, previous issuance was PNO-79-67N)

ENVIRONMENTAL STATUS

Offsite radiation levels identified by NRC survey teams continue to range between 0.01-0.1 mR/hr. The results were obtained from routine surveys performed on the east and west side of the Susquehanna River at distances of up to 4 miles north and south of the site.

The following ARMS surveys were conducted during April 8, 1979:

<u>TIME</u>	<u>MAXIMUM RADIATION LEVELS</u>	<u>LOCATION</u>	<u>DISTANCE FROM SITE</u>
00:00-00:30	1 mR/hr	sector 180° (south)	½ - 1 mile
06:00-06:20	0.3 mR/hr	sector 200° (west-southwest)	1 mile
09:00-09:50	0.03 mR/hr	sector 170° (south-southeast)	1 mile
18:05-18:30	0.05 mR/hr	sector 275° (west-northwest)	3 miles

Eight offsite air samples collected near the NRC trailer during April 1-8 indicated iodine-131 concentrations between 0.9 - 3.3 picocuries per cubic meter (pCi/m³). The maximum permissible concentration per 10 CFR 20 is 100 pCi/m³.

No new data were reported for milk, water, and vegetation samples.

Offsite dose rates as determined by NRC thermoluminescent dosimeters (TLDs) indicate that present radiation levels are in close agreement with expected natural background levels. Minor fluctuations among individual TLDs are expected due to the limitations of the TLD system. Forty-seven TLDs are presently positioned at various locations around the site.

Dose rates (47 locations) as measured by NRC thermoluminescent dosimeters have ranged from 0.01 to 0.02 milliroentgens per hour for the past 24-hour periods of April 7 and 8.

Contact: EJordan, IE x28180 NCMoseley, IE x28160

Distribution: Transmitted H St ^{9:55 AM} ~~10:00 AM~~
Chairman Hendrie Commissioner Bradford
Commissioner Kennedy Commissioner Ahearne
Commissioner Gilinsky

S. J. Chilk, SECY
C. C. Kammerer, CA
(For Distribution)

Transmitted: MNBB 10:00 AM P. Bldg 10:02 AM
L. V. Gossick, EDO H. R. Denton, NRR
H. L. Ornstein, EDO R. C. DeYoung, NRR
J. J. Fouchard, PA R. J. Mattson, NRR
N. M. Haller, MPA V. Stello, NRR
R. G. Ryan, OSP R. S. Boyd, NRR
H. K. Shapar, ELD SS Bldg 10:04 AM
W. J. Dircks, NMSS
S. Levine, RES

J. G. Davis, IE
Region I 10:10 AM
Region II 10:12 AM
Region III 10:14 AM
Region IV 10:16 AM
Region V 10:21 AM
(MAIL)
J. J. Cummings, OIA
R. Minogue, SD

IE (TMI) Site 10:07 AM (Provide copy to STATE)
White House Situation Room 10:35 AM
EPA 11:08 AM
FDA/BRH 11:30 AM
DOE/EOC 10:27 AM
FDDA/FEMA 11:30 AM
BRP (State of PA) 10:13 AM
DCPA 12:15 PM
HEW Pickup
PEMA 1100
Handcarry (FAA)

IMMEDIATE

PRELIMINARY NOTIFICATION
CORRECTED COPY

IMMEDIATE
PRELIMINARY NOTIFICATION

April 10, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67Q

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 6:00 a.m. on 4/10/79.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

PLANT STATUS

Bulk coolant inlet and outlet temperatures remain at about 280 degrees F. The average core thermocouple temperature is about 295 degrees F, and the highest thermocouple reading (8H) is about 400 degrees F.

A 24-hour period of additional degasification by reducing primary pressure to 400 psig in small decrements was completed on April 9. No significant change in reactor coolant pump vibration occurred during this period. Noise measurements did indicate some gas in the coolant at lower pressures, with return into solution over time. The licensee plans to repeat the degassing operation, cycling down to approximately 300 psig, and subsequently to hold reactor coolant system pressure at approximately 1000 psig. A phased cooldown is under consideration as the next step.

A primary coolant system sample is planned to be taken this morning.

Hydrogen concentration in containment is about 1.7%.

ENVIRONMENTAL STATUS

Offsite radiation levels identified by NRC survey teams range between .02 - .2 mR/hr. The higher level lasted only a short time and is believed to be associated with operation of the waste gas compressors. The results were obtained from routine surveys performed on the east and west side of the Susquehanna River at distances of up to 4 miles north and south of the site.

CONTINUED

The following ARMS surveys were conducted during April 9, 1979:

<u>TIME</u>	<u>MAXIMUM RADIATION LEVELS</u>	<u>LOCATION</u>	<u>DISTANCE FROM SITE</u>
12:38 - 13:08	2 mR/hr	sector 235 -270	1 mile
18:05 - 18:45	1 mR/hr	sector 120	1 mile

No new data were reported for milk, water, and vegetation samples.

Offsite dose rates as determined by NRC thermoluminescent dosimeters (TLDs) indicate that present radiation levels are in close agreement with expected natural background levels.

Dose rates (47 locations) as measured by NRC thermoluminescent dosimeters have ranged from 0.01 to 0.05 milliroentgens per hour for the past 24-hour period of April 9.

Contact: EJordan, IE x28180 NCMoseley, IE x28160

Distribution: Transmitted H St 8:10

Chariman Hendrie	Commissioner Bradford	S. J. Chilk, SECY
Commissioner Kennedy	Commissioner Ahearne	C. C. Kammerer, CA (For Distribution)

Transmitted: MNBB <u>8:18</u>	P. Bldg <u>8:13</u>	J. G. Davis, IE
L. V. Gossick, EDO	H. R. Denton, NRR	Region I <u>8:25</u>
H. L. Ornstein, EDO	R. C. DeYoung, NRR	Region II <u>8:28</u>
J. J. Fouchard, PA	R. J. Mattson, NRR	Region III <u>8:31</u>
N. M. Haller, MPA	V. Stello, NRR	Region IV <u>8:37</u>
R. G. Ryan, OSP	R. S. Boyd, NRR	Region V <u>8:40</u>
H. K. Shapar, ELD	SS Bldg <u>8:21</u>	(Mail)
	W. J. Dircks, NMSS	J. J. Cummings, OIA
	S. Levine, RES	R. Minogue, SD

IE (TMI) Site 8:15 (Provide copy to STATE)
 White House Situation Room 8:43
 EPA 9:50
 -FDA/BRH 10:30
 DOE/EOC ~~10:15~~ 10:15
 -FDDA/FEMA 10:30
 BRP (State of PA) 9:14
 DCPA 9:55
 HEW (Pickup)

Handcarry (FAA)

IMMEDIATE
PRELIMINARY NOTIFICATION

IMMEDIATE
PRELIMINARY NOTIFICATION

April 11, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67R

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on 4/11/79.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

Bulk coolant inlet and outlet temperatures remain at approximately 280 degrees F. The peak core thermocouples have declined to less than 400 degrees F for the first time, the highest thermocouple reading is 398 degrees F.

Degassing operations were continued; however, after cycling down to 425 psig, pressure had to be increased because the system letdown flow rate was not sufficient to prevent an increase in the pressurizer level caused by normal coolant pump seal water leakage into the reactor cooling system. Pressure was increased to 550 psig where some degassing occurred. Pressure was subsequently increased to approximately 940 psig, where it is being held while pressurizer level is being reduced. Continued degassing operations, with reactor pressure reduced to 300 psig, is being reexamined.

A primary coolant sample was taken at approximately 0730 on April 10, 1979. Portions of the sample will be analyzed by Bettis, B&W, Oak Ridge National Laboratory and Savannah River.

The hydrogen concentration in containment is about 1.8%. The containment temperature is about 93 degrees F; the containment fans are operating, however, the cooling water to the system was shut off at about 1600 hours on April 10, 1979 due to leakage from the shaft seal packing gland on one of the Reactor Building Emergency Cooling booster pumps in the Auxiliary Building. The containment temperature at the time the cooling water was shut off was 80 degrees F.

CONTINUED

IMMEDIATE
PRELIMINARY NOTIFICATION

Environmental Status

Offsite radiation levels identified by NRC survey teams range between 0.02 - 0.12 mR/hr. The radiation levels appeared to be lower than yesterday. The results were obtained from routine surveys performed on the east side of the Susquehanna River at distances of up to 2 1/2 miles north and south of the site. The primary coolant sampling resulted in no discernable effect on these radiation levels.

At the request of NRC, a whole-body counter was set up in Middletown on April 10, 1979, by the Commonwealth of Pennsylvania Department of Environmental Resources. Over 300 residents who live within a 3-mile radius of Three Mile Island have signed up to be scanned. As of 1600 hours on April 10, 1979, 24 people who live closest to the site and whose families have milk cows for their own use have been scanned. The scan results reported thus far do not indicate radiation levels above normal body levels. It is expected that counting will continue until at least Saturday, April 14, 1979.

The following ARMS surveys were conducted during April 10, 1979:

<u>Time</u>	<u>Maximum Radiation Levels</u>	<u>Location</u>	<u>Distance From Site</u>
0627-0800	0.1 mR/hr	sector 310 ⁰	1 mile
1833-1913	0.15 mR/hr	sector 340 ⁰	1 mile

The State of Pennsylvania reported that an air sample taken at the observation center from March 22 to April 2 indicated 2.4 picocuries per cubic meter of iodine-131. The NRC took a 24-hour air sample near the observation center starting at 1600 hours on April 9, 1979. The results indicated 4.2 picocuries per cubic meter of iodine-131. The 10 CFR 20 limit for iodine-131 is 100 picocuries per cubic meter.

A soil and vegetable sample taken by NRC in Goldsboro on April 10, 1979 indicated no detectable activity.

Thirty-five milk samples were collected by various Federal and State agencies on April 5-6, 1979. All were less than the minimum detectable activity of 10 picocuries per liter of iodine-131.

CONTINUED

IMMEDIATE
PRELIMINARY NOTIFICATION

DOE collected samples from 0800 hours on April 9 to 1600 hours on April 10, 1979, and analyzed for iodine-131. Results were as follows:

- 15 water samples - no detectable activity
- 12 vegetable samples - no detectable activity
- 4 soil samples - no detectable activity
- 1 air sample near Goldsboro - 8.5 picocuries per cubic meter

Dose rates (47 locations) as measured by NRC thermoluminescent dosimeters have ranged from 0.01 to 0.03 milliroentgens per hour for the past 24-hour period of April 10, 1979. These levels are in close agreement with expected natural background levels.

Contact: RCPaulus, IE x 27246: DThompson, IE x28487

Distribution: Transmitted H St 7:27
Chairman Hendrie Commissioner Bradford S. J. Chilk, SECY
Commissioner Kennedy Commissioner Ahearne C. C. Kammerer, CA
Commissioner Gilinsky (For Distribution)

Transmitted: MNBB 7:41 P. Bldg 7:33 J. G. Davis, IE
L. V. Gossick, EDO H. R. Denton, NRR Region I 7:49
H. L. Ornstein, EDO R. C. DeYoung, NRR Region II 7:56
J. J. Fouchard, PA R. J. Mattson, NRR Region III 8:07
N. M. Haller, MPA V. Stello, NRR Region IV 8:19
R. G. Ryan, OSP R. S. Boyd, NRR Region V 8:38
H. K. Shapar, ELD SS Bldg 7:45 (MAIL)
W. J. Dircks, NMSS J. J. Cummings, OIA
S. Levine, RES R. Minogue, SD

IE (TMI) Site 7:36 (Provide copy to STATE)
White House Situation Room 11:10
EPA 10:40
FDA ~~APR~~ 12:30
DOE/EOC 10:20
PEMA 3:20
BRP (State of PA) 2:10
DCPA 3:30
HEW (Pickup)
~~FOC~~
Handcarry (FAA)

IMMEDIATE
PRELIMINARY NOTIFICATION

IMMEDIATE
PRELIMINARY NOTIFICATION

April 12, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE -- PNO-79-67S

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on April 12, 1979.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

Bulk coolant inlet and outlet temperatures remain at approximately 280 degrees F. The peak core thermocouples remain less than 400 degrees F with the exception that one thermocouple read 401⁰F during reduced pressure operation.

The degassing operations were completed at about 0115 on April 12, 1979. The minimum reactor coolant system pressure was 303 psig. Noise analysis evaluations indicate considerable degassing took place during these operations. Pressure is being returned to about 1000 psig and will be held at that level.

A second pressurizer level measuring channel failed at 2045 on April 11, 1979. There is one original pressurizer level channel still operating. An approved procedure is available for monitoring pressurizer level by balancing makeup tank level. Calibration of the Heise pressure gauge (backup level indicator installed several days ago) is planned during the current increase in pressure; it is expected this will provide an additional method of monitoring pressurizer level.

Cooling water flow was restored to the coolers in the containment at 0730 on April 11, 1979, and the containment temperatures have decreased from about 93 degrees F to about 85 degrees F. The hydrogen concentration in containment is about 1.6%.

Preliminary results of the primary coolant samples analyzed at Oak Ridge and Savannah River have been received. Very little uranium was identified in either sample, supporting previous analyses which formed the basis to conclude insignificant fuel melting occurred.

Changeout of the Auxiliary Building filters has commenced. Filters on its condenser vacuum pumps are expected to be operational today.

CONTINUED

Environmental Status

Offsite radiation levels identified by NRC survey teams range between 0.02 and 0.1 mR/hr. The radiation levels continue to be low. The results were obtained from routine surveys performed on the east and west sides of the Susquehanna River at distances up to five miles north and south of the site.

By 7:00 a.m. on April 12, one hundred seventy-six local residents were scanned with the whole-body counter which was set up in Middletown. The scan results reported do not indicate radiation levels above normal body levels. Over 650 individuals have signed up to be scanned.

The following Aerial Measuring System surveys were conducted on April 11. These were previously reported as ARMS surveys. Winds were calm during these surveys.

<u>Time</u>	<u>Max. Radiation Level</u>	<u>Distance from Site</u>
0917-0452	0.025 mR/hr	1 mile
1700-1735	0.010 mR/hr	1 mile

The State of Pennsylvania reported that an air sample taken at the observation center from April 2 to April 10 indicated 1.4 picocuries per cubic meter of iodine-131. The NRC took a 24-hour air sample near the observation center starting at 1600 hours on April 10, 1979. The results indicated 1.6 picocuries per cubic meter of iodine-131. The 10 CFR 20 limit for iodine-131 is 100 picocuries per cubic meter.

Dose rates (47 locations) as measured by NRC thermoluminescent dosimeters have ranged from 0.01 to 0.02 milliroentgens per hour for the past 24-hour period of April 11, 1979. These levels are in close agreement with expected natural background levels.

At 0100 hours on April 12, 1979, two tanks previously used as temporary storage for Unit 2 condensate storage tank overflow left the site for New Jersey to undergo some repair work. The tanks had been flushed previously and sample results from one tank indicated levels of radioactivity of 1×10^{-6} uCi/ml gross beta activity. While the truck drivers had obtained property releases for the tanks they had not obtained radiation safety releases. Shortly after the trucks departed the site, the error was realized. At the request

CONTINUED
IMMEDIATE PRELIMINARY NOTIFICATION

of the Unit 2 Shift Supervisor, NRC personnel contacted the Pennsylvania State Police and the truck from which the high gross beta activity sample was obtained was intercepted about 5 miles outside of Harrisburg and escorted back to the site where it arrived at about 0300 hours. The returned tank was surveyed and no leakage or external radiation levels were detected. A sample of the tank's residual liquid contents was taken and is being analyzed. The licensee is making procedural revisions to prevent recurrence of the problem.

Corrections:

PNO-79-67N, dated April 8 - Item b on page 3 listed the MPC for iodine-131 as 100 picocuries per liter. It should have read 300 picocuries per liter.

PNO-79-67R, dated April 11 - On page 2, the ARMS results were listed as 0.15 mR/hr for the 1833 to 1913 survey. It should have read 0.015 mR/hr. Also the ARMS surveys were described as being in sector 310° for the 0627-0800 survey and in sector 340° for the 1833 - 1913 survey. It should have read 130° and 160°, respectively.

Contact: RCPaulus, IE x27246 DThompson, IE x28487

Distribution:

Chairman Hendrie
Commissioner Kennedy
Commissioner Gilinsky

Transmitted H St 9:48
Commissioner Bradford
Commissioner Ahearne

S. J. Chilk, SECY
C. C. Kammerer, CA
(For Distribution)

Transmitted: MNBB 9:53
L. V. Gossick, EDO
H. L. Ornstein, EDO
J. J. Fouchard, PA
N. M. Haller, MPA
R. G. Ryan, OSP
H. K. Shapar, ELD

P. Bldg 9:44
H. R. Denton, NRR
R. C. DeYoung, NRR
R. J. Mattson, NRR
V. Stello, NRR
R. S. Boyd, NRR
SS Bldg 9:57
W. J. Dircks, NMSS
S. Levine, RES

J. G. Davis, IE
Region I 10:42
Region II 10:05
Region III 10:20
Region IV 10:32
Region V 10:54
(MAIL)
J. J. Cummings, OIA
R. Minogue, SD

IE (TMI) Site 10:25 (Provide copy to STATE)
White House Situation Room 10:17
FDAA 9:47 (Provide copies to the Administrator and the Operations Center)
EPA ~~11:10~~ 11:10
DOE/EOC 10:38
PEMA 12:45
BRP (State of PA) 11:31
DCPA 1:50
HEW (Pickup)
Handcarry (FAA)

IMMEDIATE
PRELIMINARY NOTIFICATION

IMMEDIATE
PRELIMINARY NOTIFICATION

April 13, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE -- PNO-79-67T

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on April 13, 1979.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

Bulk coolant inlet and outlet temperatures remain at approximately 280 degrees F. The peak core thermocouple readings have declined to below 385 degrees F. The primary system pressure is being maintained between 950 psig and 1000 psig.

There are presently two of the three original pressurizer level channels in operation (the pressurizer level indicator that was reported to have failed on April 11 started to function again at 1955 on April 12 and has been tracking reasonably well). Calibration of the Heise pressure gauge is in progress. A differential pressure sensor is being installed on the pressurizer instrument lines in an attempt to provide an additional method of monitoring pressurizer level.

The hydrogen recombiner tripped off at 0115 on April 13 (burned out heaters). The hydrogen concentration in the containment building was about 1.5% at 2200 on April 12. A decision has not been made whether to replace the heaters or to initiate operation of the backup recombiner.

Environmental Status

The maximum offsite radiation level identified by NRC survey teams was 0.02 mR/hr. The results were obtained from routine surveys performed on the east and west sides of the Susquehanna River at distances up to five miles north and south of the site.

By 4:15 p.m. on April 12, 214 local residents were scanned with the whole-body counter which was set up in Middletown. The scan results reported to not indicate radiation levels above normal body levels.

CONTINUED
IMMEDIATE PRELIMINARY NOTIFICATION

The following Aerial Measuring System surveys were conducted on April 12. Winds were calm during these surveys.

<u>Time</u>	<u>Max. Radiation Level</u>	<u>Distance from Site</u>
0938 - 1016	0.03 mR/hr	1 mile
1510 - 1603	0.01 mR/hr	1000 feet

The NRC took a 24-hour air sample near the observation center starting at 1600 hours on April 11, 1979. The results indicated less than 2.2 picocuries per cubic meter of iodine-131. The 10 CFR 20 limit for iodine-131 is 100 picocuries per cubic meter.

Dose rates (47 locations) as measured by NRC thermoluminescent dosimeters for the past 24-hour period of April 12, are in close agreement with expected natural background levels.

Samples of air, water, soil and vegetation continue to be analyzed by Federal agencies. DOE reported the following positive results:

2 of 30 vegetation samples yielded 80 to 260 microcuries per square meter ($\mu\text{Ci}/\text{m}^2$) iodine-131. The minimum detectable activity (MDA) is 30 $\mu\text{Ci}/\text{m}^2$. The remaining 28 samples were below MDA. 12 soil samples were less than the MDA of 600 $\mu\text{Ci}/\text{m}^2$.

All air and water analyses by DOE and EPA were less than the MPC in 10 CFR 20.

Exposures of Met Ed and Contractor personnel from March 29 to April 11 are:

<u>Dose Range (Whole Body Gamma)</u>	<u>Number in Range</u>
100 - 250 mrem	118
251 - 500 mrem	25
501 - 750 mrem	12
751 - 1000 mrem	2
1000 - 2000 mrem	3
2000 - 3000 mrem	0
3000 - 4000 mrem	3*

* Reported in PNO-79-67K

Contact: RCPaulus, IE x27246 DThompson, IE x28487

Distribution: Transmitted H St 7:16
Chairman Hendrie Commissioner Bradford
Commissioner Kennedy Commissioner Ahearne
Commissioner Gilinsky

S. J. Chilk, SECY
C. C. Kammerer, CA
(For Distribution)

Transmitted: MNBB 7:30
L. V. Gossick, EDO
H. L. Ornstein, EDO
J. J. Fouchard, PA
N. M. Haller, MPA
R. G. Ryan, OSP
H. K. Shapar, ELD

P. Bldg 7:34
H. R. Denton, NRR
R. C. DeYoung, NRR
R. J. Mattson, NRR
V. Stello, NRR
R. S. Boyd, NRR
SS Bldg 7:38
W. J. Dircks, NMSS
S. Levine, RES

J. G. Davis, IE
Region I 7:42
Region II 7:53
Region III 7:57
Region IV 8:03
Region V 8:07
(MAIL)
J. J. Cummings, OIA
R. Minogue, SD

IE (TMI) Site 7:21 (Provide copy to STATE)

White House Situation Room 7:52

FDA 7:25 (Provide copies to the Administrator and the Operations Center)

EPA 8:17

DOE/EOC 9:05

PEMA 9:40

BRP (State of PA) 8:18

DCPA 8:42

HEW (Pickup)

Handcarry (FAA)

IMMEDIATE
PRELIMINARY NOTIFICATION

IMMEDIATE
PRELIMINARY NOTIFICATION

April 13, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE -- PNO-79-67T (Correcti

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on April 12, 1979.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

The radiation activity for soil and vegetation samples on page 2 of PNO-79-67T should read:

".... 80 to 260 picocuries per square meter (pCi/m²) iodine-131.

The minimum detectable activity (MDA) is 30 pCi/m². The remaining 28 samples were below MDA. Twelve (12) soil samples were less than the MDA of 600 pCi/m²."

Contact: RCPaulus, IE x27246; DThompson, IE x28487

Distribution: Transmitted H St 9:45a

Chairman Hendrie

Commissioner Bradford

S. J. Chilk, SECY

Commissioner Kennedy

Commissioner Ahearne

C. C. Kammerer, CA

Commissioner Gilinsky

(For Distribution)

Transmitted: MNBB 9:46a

P. Bldg 9:48

J. G. Davis, IE

L. V. Gossick, EDO

H. R. Denton, NRR

Region I 9:55

H. L. Ornstein, EDO

R. C. DeYoung, NRR

Region II 10:06

J. J. Fouchard, PA

R. J. Mattson, NRR

Region III 10:00

N. M. Haller, MPA

V. Stello, NRR

Region IV 10:02 10:05

R. G. Ryan, OSP

R. S. Boyd, NRR

Region V 10:03

H. K. Shapar, ELD

SS Bldg 9:50

(MAIL)

W. J. Dircks, NMSS

J. J. Cummings, OIA

S. Levine, RES

R. Minogue, SD

IE (TMI) Site 9:56 (Provide copy to STATE)

White House Situation Room 10:35

FDA 10:45 (Provide copies to the Administrator and the Operations Center)

EPA 10:55

DOE/EOC 10:20

PEMA 11:00

BRP (State of PA) 11:10

DCPA 11:20

HEW (Pickup)

Handcarry (FAA)

IMMEDIATE

PRELIMINARY NOTIFICATION

(PNO-79-67T (Correction))

IMMEDIATE
PRELIMINARY NOTIFICATION

April 14, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67U

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on April 14, 1979.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status:

At 1003 on April 13, 1979, cooldown of the primary coolant system was initiated marking the first step toward placing the reactor into natural circulation. It is anticipated that the primary system would be cooled from 280 degrees F to approximately 230 degrees F during this phase. As of 0200 on April 14, primary coolant temperature had decreased to approximately 250 degrees F and cooldown had slowed considerably. Four of the incore thermocouple readings remained above 300 degrees F with the highest at 350 degrees F.

A pressurized primary coolant sample was taken on April 13 and is being sent to Idaho Falls, Idaho for analysis by Allied Chemical. The sample left Harrisburg at 0400 on April 14 and estimated time of arrival at Idaho Falls is 0945 EST.

Environmental Status:

Offsite radiation levels identified by NRC survey teams were consistent with normal background levels (0.02 mR/hr maximum). The results were obtained from routine surveys performed on the east and west sides of the Susquehanna River at distances up to five miles north and south of the site.

By 11:15 a.m. on April 13, 1979, 292 local residents were scanned with the whole body counter located in Middletown. Scan results indicate no radiation levels above normal body levels.

The following Aerial Measuring System surveys were conducted on April 13. Wind speed ranged from 14 to 16 mph. No defined plume was identified.

<u>Time</u>	<u>Max. Radiation Level</u>	<u>Distance from Site</u>
0908 - 0940	0.03 mR/hr	1000 feet
1454 - 1530	0.03 mR/hr	900 feet

CONTINUED
IMMEDIATE PRELIMINARY NOTIFICATION

The NRC took a 24-hour air sample near the observation center starting at 1600 hours on April 12, 1979. The results indicated less than 1.5 picocuries per cubic meter of iodine-131. The 10 CFR 20 limit for iodine-131 is 100 picocuries per cubic meter.

Dose rates (47 locations) as measured by NRC thermoluminescent dosimeters for the past 24-hour period of April 13 are near expected natural background levels.

The State of Maryland reported finding less than 6 picocuries of iodine per liter of milk in 6 samples taken during April 7 to April 11. The milk samples were taken from farms around TMI.

Sixty-two EPA air samples collected on April 9 and 10, indicated no detectable activity, while six indicated activities which ranged from 0.092 to 0.81 picocuries per cubic meter of iodine-131. EPA samples of milk, soil, vegetation, water and various species of fish did not reveal any activity above background.

Correction to PNO-79-67E dated March 31, 1979. The initial report of licensee TLD data was based on a telephone report. The following is based on the TLD vendor's formal report. The first quarter 1979 TLD readings ranged from background to a high of 1044 mR at the licensee fence in the NNW sector. The highest reading TLD located in an offsite populated area was about 26 mR of which about 15 mR was background exposure. A TLD located midway across the north bridge about 0.3 miles NNE of the plant recorded 44 mR, including background. These revised estimates do not significantly affect previous estimates of population doses.

CONTINUED
IMMEDIATE PRELIMINARY NOTIFICATION

Contact: RCPaulus, IE x27246 DThompson, IE x28487

Distribution: Transmitted H St 10:25

Chairman Hendrie
Commissioner Kennedy
Commissioner Gilinsky

Commissioner Bradford
Commissioner Ahearne

S. J. Chilk, SECY
C. C. Kammerer, CA
(For Distribution)

Transmitted: MNBB 10:28

L. V. Gossick, EDO
H. L. Ornstein, EDO
J. J. Fouchard, PA
N. M. Haller, MPA
R. G. Ryan, OSP
H. K. Shapar, ELD

P. Bldg 10:32

H. R. Denton, NRR
R. C. DeYoung, NRR
R. J. Mattson, NRR
V. Stello, NRR
R. S. Boyd, NRR
SS Bldg 10:36
W. J. Dircks, NMSS
S. Levine, RES

J. G. Davis, IE

Region I 10:43
Region II 10:50
Region III 10:53
Region IV 10:59
Region V 11:04
(MAIL)

J. J. Cummings, OIA
R. Minogue, SD

IE (TMI) Site 10:39 (Provide copy to STATE)

White House Situation Room 1324

FDAA 13:04 (Provide copies to the Administrator and the Operations Center)

EPA

DOE/EOS 11:11

PEMA

BRP (State of PA) 1407

DCPA 1345

HEW (Pickup)

Handcarry (FAA)

IMMEDIATE
PRELIMINARY NOTIFICATION

IMMEDIATE
PRELIMINARY NOTIFICATION

April 15, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE--PNO-79-67V

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on April 15, 1979.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status:

As of 0600 on April 15, 1979, primary coolant temperature had stabilized at approximately 250 degrees F. Four of the incore thermocouple readings remain above 300 degrees F with the highest at 348 degrees F.

The hydrogen recombiner that failed on April 13 has been repaired and is in the process of being restored to service.

The staff has completed a preliminary evaluation of TMI-2 fuel damage. Examinations of data from core thermocouples, incore detectors and excore ion chambers, and analyses of core parameters such as primary coolant pressure for the first fifteen hours of the transient show several periods of significant core uncovering. These were time periods during which portions of the fuel elements were cooled by steam rather than pressurized water which is the normal cooling method.

It was during these periods of deficient cooling that extensive damage to the fuel elements occurred. This damage occurred primarily by oxidation of the fuel cladding and other zirconium alloy components, which were embrittled and lost structural integrity in some regions of the core. Estimates of the extent of damage were calculated from fission product and hydrogen releases inside the plant and radiochemical analysis of the reactor coolant water. The analyses indicate that significant cladding oxidation occurred in the upper regions of the core and most fuel rods have some damage. The core geometry in the upper regions of the core, especially near the center, is believed to be severely distorted due to loss of fuel cladding integrity in that region. However, the lower and peripheral portions of the core are believed to have retained their basic structural integrity. The highest fuel temperature during the transient is estimated by these damage mechanism analyses to be well below the 5100 degrees F fuel melting point. Previous results of radiochemical analyses of primary coolant samples support this conclusion of little or no fuel melting.

CONTINUED
IMMEDIATE PRELIMINARY NOTIFICATION

Environmental Status:

Offsite radiation levels identified by NRC survey teams were consistent with normal background levels (0.02 mR/hr maximum). The results were obtained from routine surveys performed on the east and west sides of the Susquehanna River at distances up to five miles north and south of the site.

By 9:30 a.m. on April 14, 1979, 375 local residents were scanned with the whole body counter located in Middletown. Scan results indicate no radiation levels above normal body levels.

The following Aerial Measuring System surveys were conducted on April 14. Wind speed was variable. The principle isotope is Xe-133.

<u>Time</u>	<u>Max. Radiation Level</u>	<u>Sector</u>	<u>Distance from Site</u>
1138 - 1221	0.04 mR/hr	270°	1000 feet

The NRC took a 24-hour air sample near the observation center starting at 1600 hours on April 13, 1979. The results indicated less than 3.0 picocuries per cubic meter of iodine-131. The 10 CFR 20 limit for iodine-131 is 100 picocuries per cubic meter.

Dose rates (47 locations) as measured by NRC thermoluminescent dosimeters for the past 24-hour period of April 14 are near expected natural background levels.

A pressurized primary coolant sample was taken April 13, 1979. The six individuals involved received a total radiation dose of 800 mrem. The highest individual dose was 270 mrem.

During the period of 1600 hours on April 13 to 1600 hours on April 14, DOE collected and analyzed the following samples:

<u>Number/Type</u>	<u>I-131 MDA</u>
4 Water	7×10^{-8} microcuries/cubic centimeter
4 Vegetation	0.04 nanocuries/square meter
4 Air (3 ground level and 1 helicopter)	3×10^{-12} microcuries/cubic centimeter
<u>12 Total</u>	

CONTINUED
IMMEDIATE PRELIMINARY NOTIFICATION

All water, 3 vegetation, and 1 ground level air samples indicated less than MDA for I-131. One vegetation (grass) sample indicated 0.16 nanocuries/square meter I-131. Two ground level air samples (collected at the same location and time side-by-side on April 13 at 11:45 a.m.) indicated I-131 levels of 9.5 picocuries per cubic meter. An air sample taken by helicopter 100 meters downwind of the auxiliary building stack (within the restricted area) indicated an I-131 activity of 119 picocuries per cubic meter. The 10 CFR 20 limit is 9000 picocuries per cubic meter.

The cause of this increase in radioactivity in certain environmental samples is not known but is under investigation. It is possible that the increase is the result of the change-out of the charcoal filters.

Contact: GCGower, IE x27246 DThompson, IE x28487

Distribution: Transmitted H St 1520
Chairman Hendrie Commissioner Bradford S. J. Chilk, SECY
Commissioner Kennedy Commissioner Ahearne C. C. Kammerer, CA
Commissioner Gilinsky

Transmitted: MNBB 15:55
L. V. Gossick, EDO P. Bldg 1524 J. G. Davis, IE
H. L. Ornstein, EDO H. R. Denton, NRR Region I 16:00
J. J. Fouchard, PA R. C. DeYoung, NRR Region II 16:25
N. M. Haller, MPA R. J. Mattson, NRR Region III 16:03
R. G. Ryan, OSP V. Stello, NRR Region IV 16:05
H. K. Shapar, ELD R. S. Boyd, NRR Region V 16:07
SS Bldg 15:40 (MAIL)
W. J. Dircks, NMSS J. J. Cummings, OIA
S. Levine, RES R. Minogue, SD

IE (TMI) Site 16:30 (Provide copy to STATE)
White House Situation Room 16:40
FDAA 17:40 (Provide copies to the Administrator and the Operations Center)
EPA 17:50
DOE/EQS 17:50
PEMA me
BRP (State of PA) 18:05
DCPA 18:20
HEW (Pickup)

Handcarry (FAA)

61

IMMEDIATE
PRELIMINARY NOTIFICATION

April 16, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE -- PNO-79-67W

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on April 16, 1979.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status:

The primary coolant temperature remains at approximately 250 degrees F. Four of the incore thermocouple readings remain above 300 degrees F with the highest at 344 degrees F.

The hydrogen recombiner that failed on April 13 has been repaired and is in service. At 0800 on April 15, 1979, the hydrogen concentration was reported to be 1.46% compared to the reading of 1.48% reported at 2200 hrs. on April 12, 1979 before the recombiner failed.

Environmental Status:

Offsite radiation levels indentified by NRC survey teams were consistent with normal background levels (0.02 mR/hr. maximum). The results were obtained from routine surveys performed on the east and west sides of the Susquehanna River at distances up to five miles north and south of the site.

By 4:00 p.m. on April 15, 1979, 482 local residents had been scanned with the whole body counter located in Middletown. Scan results indicated no radiation levels above normal body levels.

The following Aerial Measuring System survey was conducted on April 15. Wind speed variable 5-20 mph.

<u>Time</u>	<u>Max. Radiation Level</u>	<u>Sector</u>	<u>Distance from Site</u>
1700-1815	0.013 mR/hr	120°	1/4 mile (elevation 300 ft)

CONTINUED
IMMEDIATE
PRELIMINARY NOTIFICATION

The NRC took an air sample near the observation center starting at 1200 on April 14 and ending at 1700 on April 15. Analysis of this sample indicated that the concentration of iodine-131 during the 29 hour period averaged 4.1×10^{-12} uc/cc.

Dose rates (47 locations) as measured by NRC thermoluminescent dosimeters for the past 24-hour period of April 16 are near expected natural background levels.

Iodine cartridge measurements (from the Unit 2 vent stack) indicate that increased iodine release rates began occurring on or around April 12. Iodine concentrations measured in the ventilation stack are:

<u>Time</u>	<u>Activity (uc/cc)</u>
4/10 (1608) - 4/11 (1800)	2.3×10^{-8}
4/11 (1920) - 4/13 (2315)	1.2×10^{-7}
4/14 (1030) - 4/14 (1915)	1.4×10^{-7}
4/14 (1915) - 4/15 (0525)	2.5×10^{-7}
4/15 (0525) - 4/15 (0804)	2.7×10^{-7}
4/15 (0805) - 4/15 (1802)	3.8×10^{-7}
4/15 (1802) - 4/15 (2140)	2.1×10^{-7}

Environmental samples obtained during this period have shown some increase in radioactivity. While the exact source of the increased activity has not been determined, it may be related to changeout of filters in the Auxiliary Building and/or tripout of the Auxiliary Building ventilation fan. Efforts are in progress to correlate work activities with the increased Iodine concentrations.

On April 15 and 16, DOE, NRC, and the licensee measured Iodine levels in the switchyard, 0.6 miles east of the reactor site. Airplane over-flight occurring at the same time indicated a very narrow plume. Recent measurements (0200 4/16) indicated 9.4×10^{-11} uc/cc for NRC sample, 7.4×10^{-11} uc/cc for licensee sample and 6.0×10^{-11} uc/cc for the DOE sample. The MPC for iodine-131 in unrestricted areas is 1×10^{-10} uc/cc. All samples were side by side samples.

The State of Pennsylvania has been informed of these results. In addition, the State will be provided with the DOE samples for analysis.

Contact: GCGower, IE x 27246; DThompson, IE x 28487

CONTINUED
IMMEDIATE
PRELIMINARY NOTIFICATION

Distribution: Transmitted H St 12:42
Chairman Hendrie Commissioner Bradford S. J. Chilk, SECY
Commissioner Kennedy Commissioner Ahearne C. C. Kammerer, CA
Commissioner Gilinsky (For Distribution)

Transmitted: MNBB 12:46 P. Bldg 1:18 J. G. Davis, IE
L. V. Gossick, EDO H. R. Denton, NRR Region I 1:27
H. L. Ornstein, EDO R. C. DeYoung, NRR Region II 1:30
J. J. Fouchard, PA R. J. Mattson, NRR Region III 1:35
N. M. Haller, MPA V. Stello, NRR Region IV 1:40
R. G. Ryan, OSP R. S. Boyd, NRR Region V 1:50
H. K. Shapar, ELD SS Bldg 1:24 (MAIL)
W. J. Dircks, NMSS J. J. Cummings, OIA
S. Levine, RES R. Minogue, SD

IE (TMI) Site 12:50 (Provide copy to STATE)
White House Situation Room 2:20
FDAA 2:02 (Provide copies to the Administrator and the Operations Center)
EPA ~~2:15~~ 3:25
DOE/EOC 1:55
PEMA 2:42
BRP (State of PA) ~~2:15~~ 4:50
DCPA 4:21
HEW (Pickup)

Handcarry (FAA)

IMMEDIATE
PRELIMINARY NOTIFICATION

28

IMMEDIATE
PRELIMINARY NOTIFICATION

April 17, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE -- PNO-79-67X

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on April 17, 1979.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

The primary coolant temperature remains at approximately 250 degrees F. Three of the incore thermocouple readings remain above 300 degrees F with the highest at 340 degrees F.

As of 0330 April 17, twenty of 90 charcoal filter elements in train A of the Auxiliary Building Ventilation system have been replaced. This work began on April 12.

The containment hydrogen concentration has been tested. Results indicate a level of about 1.36%.

Environment Status

Offsite radiation levels identified by NRC survey teams were consistent with normal background levels (0.02 mR/hr. maximum) with the exception of one reading of 0.14 mR/hr. These results were obtained from routine surveys performed downwind on the east side of the Susquehanna River at distances up to five miles north and south of the site.

By 3:00 p.m. on April 16, 571 local residents had been scanned with the whole body counter located in Middletown. Scan results indicate no radiation levels above normal body levels.

An Aerial Measuring System (AMS) survey was conducted on April 16. The wind speed was 5 mph. No plume could be identified. At 1/4 mile from the reactor building, readings of 0.030 - 0.040 mR/hr were observed from 180 - 270°. These readings appeared to be independent of the wind direction.

Dose rates (47 locations) as measured by NRC thermoluminescent dosimeters (TLD's) for the past 24-hour period of April 17 are near expected natural background levels.

CONTINUED
IMMEDIATE PRELIMINARY NOTIFICATION

Iodine concentrations measured in the Unit 2 ventilation stack since PNO-79-67W (April 16, 1979) are:

<u>Time</u>	<u>Activity (uCi/cc)</u>
4/15 (2140) - 4/15 (2357)	2.5×10^{-7}
4/16 (0408) - 4/16 (0758)	2.3×10^{-7}
4/16 (1156) - 4/16 (1550)	2.1×10^{-7}
4/16 (1556) - 4/16 (1810)	3.6×10^{-7}
4/16 (1810) - 4/16 (2356)	1.4×10^{-7}

The NRC took the daily air sample near the observation center starting at 1703 on April 15 and ending at 1747 on April 16. Analysis of this sample indicated that the concentration of Iodine-131 during the 24-hour period averaged 1.7×10^{-11} uCi/cc (17 picocuries/m³) which correlates with the plume wind being in this sector a large percentage of the time.

In response to increased Iodine-131 levels observed in environmental air samples, NRC has been taking approximately 5 air samples in each 8-hour period. During the 24-hour period ending midnight - April 16, 1979, three air samples from areas downwind of the plant were between 1.1 and 1.2×10^{-10} uCi/ml (110-120 picocuries per cubic meter). The average of the 11 air samples was 6.5×10^{-11} uCi/cc (65 picocuries/m³). The 8 samples taken since 10 p.m. on April 16, 1979, have shown no activity above the MDA (approximately 20 picocuries/m³). Since the Iodine-131 release rates are similar to previous rates, the observed increases are believed due to meteorological differences. Review of plant operations and possible release paths indicate that the source of the Iodine-131 is apparently the monitored release through the ventilation stack. However several changes to in-plant conditions were made. The makeup tank pressure was reduced. A portion of the charcoal filters in the Auxiliary Building ventilation system was replaced and areas in the Auxiliary Building were sprayed with sodium hydroxide and sodium thiosulfate.

During the period April 13 to 16, a total of 54 DOE samples including 1 soil sample, 4 rain water samples, 16 standing water samples, 22 grass samples, 8 ground level air filter samples and 3 air filter samples from helicopter flights were analyzed by DOE using a GE-Li gamma spectrometer. The samples were collected in the path of air discharges from the Three Mile Island station. Fourteen of the grass samples indicated that

Iodine-131, if present, was less than the minimum detectable activity (MDA) of 4.0×10^{-5} microcuries per square meters (40 picocuries/square meter). The eight samples that showed results above MDA ranged from 4.0×10^{-5} microcuries per square meter (40 picocuries/square meters) to 7.3×10^{-4} microcuries per square meter (730 picocuries/square meters). Soil, standing water, and rain water samples all indicated less than the MDA's. The MDA for soil is 7.0×10^{-4} microcuries per square meter (700 picocuries/square meters); and for water is less than 7.0×10^{-8} microcuries per cubic centimeter (70 picocuries per liter).

The Commonwealth of Pennsylvania, DER, analyzed two milk samples taken on April 16, 1979. There was no detectable Iodine-131.

EPA analyzed nine air samples between April 10 and April 11. Iodine-131 activity ranged from 1.2×10^{-13} to 1.7×10^{-12} uCi/cc. (0.12 - 1.7 picocuries per cubic meter). Twenty-five soil samples were analyzed and showed only natural activity, including normal background levels of Cs-137. EPA TLD's from 34 locations for the period March 31 through April 8 showed background except for two, York Haven and Goldsboro, which showed 2.0 and 2.5 mR respectively for this period. Personnel badges from 44 residents for the same period showed no net exposures above background.

The Commonwealth of Pennsylvania has been informed of these results.

Contact: GCGower, IE x 27246; DThompson, IE x28487

Distribution: Transmitted H St 1:46

Chairman Hendrie	Commissioner Bradford	S. J. Chilk, SECY
Commissioner Kennedy	Commissioner Ahearne	C. C. Kammerer, CA (For Distribution)
Commissioner Gilinsky		J. G. Davis, IE
Transmitted: MNBB <u>1:49</u>	P. Bldg <u>1:53</u>	Region I <u>2:04</u>
L. V. Gossick, EDO	H. R. Denton, NRR	Region II <u>2:13</u>
H. L. Ornstein, EDO	R. C. DeYoung, NRR	Region III <u>2:20 2:45</u>
J. J. Fouchard, PA	R. J. Mattson, NRR	Region IV <u>2:20</u>
N. M. Haller, MPA	V. Stello, NRR	Region V <u>2:34</u>
R. G. Ryan, OSP	R. S. Boyd, NRR	(MAIL)
H. K. Shapar, ELD	SS Bldg <u>1:58</u>	J. J. Cummings, OIA
	W. J. Dircks, NMSS	R. Minogue, SD
	S. Levine, RES	

IE (TMI) Site 1:44 (Provide copy to STATE)
White House Situation Room 3:30
FDAA 4:07 (Provide copies to the Administrator and the Operations Center)
EPA 2:55
DOE/EOC 4:44
PEMA 2:35
BRP (State of PA) 3:55
DCPA 4:00
HEW (Pickup)
Handcarry (FAA)

DeB

IMMEDIATE
PRELIMINARY NOTIFICATION

April 18, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE -- PNO-79-67Y

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on April 18, 1979.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

The average primary coolant temperature is 236 degrees F. The decrease in primary coolant temperature was a result of an increase in the steaming rate. This increase was achieved by opening additional valves to the main condenser. Two of the incore thermocouple readings remain above 300 degrees F with the highest at 330 degrees F.

As of 0530 April 18, fifty of 90 charcoal filter elements in train A of the Auxiliary Building Ventilation system have been replaced. This work began on April 12.

Pressurizer level transmitter LT-2 became erratic over the period 1745 - 2235 on April 17 but is now tracking again. Calibration of the Heise gauge, to be used as a backup pressure level measurement, is continuing.

Environment Status

Offsite radiation levels identified by NRC survey teams were consistent with normal background levels (0.02 mR/hr. maximum). These results were obtained from routine surveys performed downwind on the east side of the Susquehanna River at distances up to five miles north and south of the site.

By 2:15 p.m. on April 17, 632 local residents had been scanned with the whole body counter located in Middletown. Scan results indicate no radiation levels above normal body levels.

No Aerial Measuring System (AMS) survey was conducted on April 17. However, an AMS survey was requested by NRC based on a short lived increase in the iodine discharge rate between 3 and 4 a.m. on April 18. The AMS survey results are not yet available.

CONTINUED
IMMEDIATE PRELIMINARY NOTIFICATION

During the 24-hour period ending midnight April 17, 1979, seven of 12 air samples showed no activity above the minimum detectable activity. None of the other five samples showed Iodine-131 greater than 1×10^{-10} uCi/cc (100 picocuries per cubic meter). On the morning of April 18, 1979, one of three samples showed Iodine-131 concentration of 2×10^{-10} microcuries/milliliter (200 picocuries per cubic meter) during the period of 3 to 4 a.m. The remaining two samples were approximately 5.0×10^{-11} microcuries/milliliter (50 picocuries/cubic meter). The last sample analyzed covered the period 0420 to 0527. The cause of the high reading is believed to be due primarily to meteorological conditions; however, several in-plant events were also in progress. They are being analyzed for possible contributions to this reading to determine appropriate corrective action. One grass sample taken downwind of the plant showed 6.13×10^{-4} microcuries per square meter (613 picocuries per square meter). Additional milk and vegetation samples have been taken, but have not been analyzed.

Dose rates (47 locations) as measured by NRC thermoluminescent dosimeters (TLD's) for the past 24-hour period of April 18 are near expected natural background levels.

Iodine concentrations measured in the Unit 2 ventilation stack since PNO-79-67X (April 17, 1979) are:

<u>Time</u>	<u>Activity (uCi/ml)</u>
4/16 (2356) - 4/17 (0402)	1.2×10^{-7}
4/17 (0402) - 4/17 (0803)	1.2×10^{-7}
4/17 (0803) - 4/17 (1226)	1.4×10^{-7}
4/17 (1226) - 4/17 (1634)	1.3×10^{-7}
4/17 (1640) - 4/17 (1946)	2.3×10^{-7}
4/17 (1958) - 4/17 (2357)	2.1×10^{-7}

The NRC took the daily air sample near the observation center starting at 1747 on April 16 and ending at 1620 on April 17. Analysis of this sample indicated that the concentration of Iodine-131 during the approximate 23-hour period averaged less than 2.4×10^{-12} uCi/cc (less than 2.4 picocuries/cubic meter). The plume wind was not in this sector a large percentage of the time during the sampling period.

No new data were available from DOE, EPA, FDA or Commonwealth of Pennsylvania, Department of Environmental Resources.

The Commonwealth of Pennsylvania has been informed of these results.

Contact: BPaulus, IE x 27246; DThompson, IE x 28487

Distribution: Transmitted H St 12:15p

Chairman Hendrie

Commissioner Kennedy

Commissioner Gilinsky

Commissioner Bradford

Commissioner Ahearne

S. J. Chilk, SECY

C. C. Kammerer, CA

(For Distribution)

Transmitted: MNBB 12:20p

L. V. Gossick, EDO

H. L. Ornstein, EDO

J. J. Fouchard, PA

N. M. Haller, MPA

R. G. Ryan, OSP

H. K. Shapar, ELD

P. Bldg 12:25

H. R. Denton, NRR

R. C. DeYoung, NRR

R. J. Mattson, NRR

V. Stello, NRR

R. S. Boyd, NRR

SS Bldg 12:36

W. J. Dircks, NMSS

S. Levine, RES

J. G. Davis, IE

Region I 12:32

Region II 12:41

Region III 12:45

Region IV 12:50

Region V 12:55

(MAIL)

J. J. Cummings, OIA

R. Minogue, SD

IE (TMI) Site 12:28 (Provide copy to STATE)

White House Situation Room 2:00

FDA 2:30 (Provide copies to the Administrator and the Operations Center)

EPA 3:25

DOE/EOC 2:55

PEMA 3:00

BRP (State of PA) 3:20

DCPA 3:45

HEW (Pickup)

Handcarry (FAA)

IMMEDIATE
PRELIMINARY NOTIFICATION

IMMEDIATE
PRELIMINARY NOTIFICATION

216

April 19, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE -- PNO-79-67Z

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on April 19, 1979.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

The average primary coolant temperature is 235 degrees F. Preparations are being made to further decrease coolant temperature by admitting steam to the main condenser through the main turbine. Two of the incore thermocouple readings remain above 300 degrees F with the highest at 329 degrees F.

Replacement of the charcoal filter elements in train A of the Auxiliary Building Ventilation system is expected to be completed this morning. Preoperational tests of train A will then be conducted.

Pressurizer level transmitter LT-2 failed at 11:30 p.m. on April 18. Calibration of an alternate method to be used as a backup pressure level measurement is continuing.

A pressurized primary coolant sample was taken at 9:45 p.m. on April 18, 1979 and sent to B&W, Lynchburg, VA. for analysis via a National Guard Aircraft at 11:35 p.m.

Environment Status

Offsite radiation levels identified by NRC survey teams were consistent with normal background levels (0.02 mR/hr maximum). These results were obtained from routine surveys performed downwind on the east side of the Susquehanna River at distances up to five miles north and south of the site.

By 7:00 p.m. on April 18, 721 local residents had been scanned with the whole body counter located in Middletown. Scan results indicate no radiation levels above normal body levels due to TMI operations. The scanning of local residents has been terminated.

An Aerial Measuring System (AMS) survey was conducted beginning at 6:38 a.m. on April 18, 1979. A plume reading 0.02 mR/hr was identified 0.25 miles SE of the plant and followed to 1.5 miles. Spectral analysis indicated

CONTINUED
IMMEDIATE PRELIMINARY NOTIFICATION

the presence of Xenon-133. An air sample taken in the plume 200 meters downwind from the stack showed 8.6×10^{-11} microcuries per cubic centimeter of Iodine-131 (86 picocuries per cubic meter).

During the period from 0530 April 18 to 0530 April 19 three of four air samples collected around the site showed no activity above the minimum detectable activity (MDA). The meteorological conditions during this period were more favorable than those of the previous day. The fourth sample shows an Iodine-131 concentration of 2.7×10^{-11} uc/cc (27 picocuries per cubic meter). Data from five other samples have not as yet been analyzed. Three soil samples and three grass samples showed no activity above the MDA. The MDA for grass was 2.4×10^{-4} microcuries per square meter (240 picocuries per square meter); the MDA for soil was about 3.7×10^{-7} microcuries per gram (0.37 picocuries per gram). One grass sample taken showed 5.5×10^{-4} microcuries per square meter (550 picocuries per square meter).

Dose rates (47 locations) as measured by NRC thermoluminescent dosimeters (TLD's) for the past 24-hour period are near expected natural background levels.

Iodine concentrations measured in the Unit 2 ventilation stack since PNO-79-67Y (April 18, 1979) are:

<u>Time</u>	<u>Activity (uCi/ml)</u>
4/17 (2357) - 4/18 (0405)	2.2×10^{-7}
4/18 (0405) - 4/18 (0550)	4.5×10^{-7}
4/18 (0550) - 4/18 (0800)	2.1×10^{-7}
4/18 (0805) - 4/18 (0945)	1.8×10^{-7}
4/18 (0945) - 4/18 (1200)	1.4×10^{-7}
4/18 (1204) - 4/18 (1647)	7.2×10^{-8}
4/19 (0001) - 4/19 (0358)*	7.5×10^{-8}

*The stack monitor used for these measurements was out of service from 12:00 a.m. on April 18 to 12:00 p.m. April 18, 1979.

CONTINUED
IMMEDIATE PRELIMINARY NOTIFICATION

The NRC took the daily air sample near the observation center starting at 1600 on April 17 and ending at 1600 on April 18. Analysis of this sample indicated that the concentration of Iodine-131 during the approximate 24-hour period averaged less than 2.6×10^{-12} microcuries per milliliter (less than 2.6 picocuries per cubic meter).

EPA submitted airborne iodine analyses of air samples collected from 31 stations on April 12 and 13. Nineteen of the samples were reported to have positive measurements of Iodine-131 from 7.2×10^{-14} microcuries per cubic centimeter (0.072 picocuries per cubic meter) for a location 25 miles west of the plant to 6.6×10^{-13} microcuries per cubic centimeters (0.66 picocuries per cubic meter) at a location about 5 miles west of the plant. EPA air samples collected on April 14 showed positive Iodine-131 on 6 of the 31 samples with a range of 1.5×10^{-13} to 7.9×10^{-13} microcuries for cubic centimeter (0.15 to 0.79 picocuries per cubic meter). EPA milk samples collected on April 12, 13 and 14 from 9 locations were less than MDA (10-15 picocuries per liter). Soil and vegetation samples collected on April 11 showed no activity above background.

On April 18, during a tour by NRC personnel of Hill Island, adjacent to TMI, three persons were observed. Two of the persons reported that they had been on Hill Island on March 28-30, 1979. An evaluation of their exposure is in progress. One of the three has already been counted in the whole body counter in Middletown.

The Commonwealth of Pennsylvania has been informed of these results.

Contact: RPaulus, IE x27246; DThompson, IE x28487

Distribution: Transmitted H St 12:44
Chairman Hendrie Commissioner Bradford S. J. Chilk, SECY
Commissioner Kennedy Commissioner Ahearne C. C. Kammerer, CA
Commissioner Gilinsky (For Distribution)
Transmitted: MNBB 12:49 P. Bldg 12:52 J. G. Davis, IE
L. V. Gossick, EDO H. R. Denton, NRR Region I 1:38
H. L. Ornstein, EDO R. C. DeYoung, NRR Region II 1:02
J. J. Fouchard, PA R. J. Mattson, NRR Region III 1:07
N. M. Haller, MPA V. Stello, NRR Region IV 1:17
R. G. Ryan, OSP R. S. Boyd, NRR Region V 1:31
H. K. Shapar, ELD SS Bldg 12:57 (MAIL)
W. J. Dircks, NMSS J. J. Cummings, OIA
S. Levine, RES R. Minogue, SD
IE (TMI) Site 1:12 (Provide copy to STATE)
White House Situation Room 2:31
FDAA 2:14 (Provide copies to the Administrator and the Operations Center)
EPA 1:44
DOE/EOC 1:24
PEMA 3:05
BRP (State of PA) 3:25
DCPA 4:03
HEW (Pickup)
Handcarry (FAA)

IMMEDIATE
PRELIMINARY NOTIFICATION

April 20, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE -- PNO-79-67AA

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on April 20, 1979.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

The average primary coolant temperature is 185 degrees F. The drop in temperature of 50 degrees F is due to steam being admitted directly to the main condenser through the main turbine. The highest incore thermocouple reading is 284 degrees F.

Replacement of the charcoal filter elements in Train A of the Auxiliary Building Ventilation System is completed. Work is in progress to replace several HEPA filters in the system. Train A is expected to be in service today.

Environmental Status

Offsite radiation levels identified by NRC survey teams were consistent with normal background levels (0.02 mR/hr maximum). These results were obtained from routine surveys performed downwind on the east and west sides of the Susquehanna River at distances up to five miles north and south of the site.

An Aerial Measuring System (AMS) survey was conducted beginning at 6:05 p.m. on April 19, 1979. A small plume reading 0.007 mR/hr was identified 0.25 miles SSE of the plant. Spectral analysis indicated the presence of a small amount of Xenon-133. An air sample taken in the plume showed no iodine-131.

During the period from 5:30 a.m. April 19 to 5:30 a.m. April 20, ten air samples collected around the site showed no activity above the minimum detectable activity (MDA). The five air samples taken between 5:30 a.m. April 18 and 5:30 a.m. April 19 (and not analyzed prior to issuance of PNO-79-67Z) showed no activity above the MDA. Two of three soil samples showed no activity above the MDA. The other soil sample showed 2.8×10^{-7} microcuries per gram of iodine-131. The MDA for soil was 1.4×10^{-7} microcuries per gram. All MDA's have been reduced (sensitivity increased) by a factor of two due to addition of a shield to the detector in the NRC's mobile laboratory.

Dose rates (47 locations) as measured by NRC thermoluminescent dosimeters (TLD's) for the past 24-hour period are near expected natural background levels.

CONTINUED
IMMEDIATE PRELIMINARY NOTIFICATION

Iodine concentrations measured in the Unit 2 ventilation stack since PNO-79-67Z (April 19, 1979) are:

<u>Time</u>	<u>Activity (uCi/cc)</u>
4/19 (0358) - 4/19 (0800)	6.6 x 10 ⁻⁸
4/19 (0803) - 4/19 (1210)	1.0 x 10 ⁻⁷
4/19 (1226) - 4/19 (1634)	1.8 x 10 ⁻⁷
4/19 (1728) - 4/19 (2025)	1.8 x 10 ⁻⁷
4/19 (2025) - 4/20 (0001)	1.2 x 10 ⁻⁷
4/20 (0001) - 4/20 (0351)	3.3 x 10 ⁻⁷

The NRC took the daily air sample near the observation center starting at 4:00 p.m. on April 18 and ending at 4:00 p.m. on April 19. Analysis of this sample indicated that the concentration of Iodine-131 during the 24-hour period averaged less than 2.4 x 10⁻¹² microcuries per cubic centimeter (less than 2.4 picocuries per cubic meter).

No additional environmental data have been received from EPA or FDA.

The three persons found on Hill Island on April 18, 1979 have been whole body counted. No radiation levels above normal body levels were found.

As stated in PNO-79-67Z, the whole body scanning program for local residents has been completed. A joint press release on this subject was issued by the Commonwealth of Pennsylvania and the NRC on this date. A copy of the press release is attached to this PN.

The Commonwealth of Pennsylvania has been informed of these results.

Attachment: Press Release dated 4/20/79

Contact: RCPaulus, IE x27246 DThompson, IE x27246

Distribution: Transmitted H St 10:25

Chairman Hendrie	Commissioner Bradford	S. J. Chilk, SECY
Commissioner Kennedy	Commissioner Ahearne	C. C. Kammerer, CA
Commissioner Gilinsky		(For Distribution)
Transmitted: MNBB <u>10:44</u>	P. Bldg <u>11:05</u>	J. G. Davis, IE
L. V. Gossick, EDO <u>10:58</u>	H. R. Denton, NRR	Region I <u>11:15</u>
H. L. Ornstein, EDO	R. C. DeYoung, NRR	Region II <u>11:20</u>
J. J. Fouchard, PA	R. J. Mattson, NRR	Region III <u>11:25</u>
N. M. Haller, MPA	V. Stello, NRR	Region IV <u>11:32</u>
R. G. Ryan, OSP	R. S. Boyd, NRR	Region V <u>11:35</u>
H. K. Shapar, ELD	SS Bldg <u>11:45</u>	(MAIL)
	W. J. Dircks, NMSS	J. J. Cummings, OIA
	S. Levine, RES	R. Minogue, SD

IE (TMI) Site 11:50 (Provide copy to STATE)
White House Situation Room 3:53
FDAA 12:40 (Provide copies to the Administrator and the Operations Center)
EPA 2:06
DOE/EOC 2:48
PEMA 12:00
BRP (State of PA) 10:40
DCPA 12:00
HEW (Pickup)

IMMEDIATE
PRELIMINARY NOTIFICATION

ATTACHMENT 1

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555



FOR IMMEDIATE RELEASE
(Friday April 20, 1979)

Middletown, Pennsylvania -- An examination of 721 persons who live close to the site of the accident that occurred March 28, 1979 at Three Mile Island has shown them to have no internal contamination from the accident, officials of the Pennsylvania Departments of Health and Environmental Resources and the Nuclear Regulatory Commission announced today. The screening program by means of a process called whole body counting was conducted jointly by these agencies, using a portable computerized detector housed in a truck parked in front of the Middletown Community Building, about three miles from the site.

The examination of these people found no radioactive elements, such as iodine-131, that have been released from the Three Mile Island facility. Trace amounts of radionuclides that are normally found in people everywhere, such as potassium-40 and cesium-137, were found by the examination.

Nine of the persons examined showed slightly more than normal amounts of naturally occurring radioactive elements that come from the noble gas radon-222 and that are called "radon daughters", because these come from the radioactive decay of radon. All nine persons have been informed by agency officials of the finding of these radon daughters in more than normal amounts. They have been told that these elements are not related to the Three Mile Island incident and that the most likely source is the natural release of low amounts of radon gas from building materials used in their homes or possibly in work places, built of stone or brick, or from other natural sources. The levels detected do not warrant any concern for the health of these nine persons and others living with them.

The 721 persons tested generally lived within three-miles of the site, on both the east and west shores of the Susquehanna River. Children as well as adults were surveyed in this program, which took place over a period of eight days and ended at 7 p.m. Wednesday, April 18.

####

IMMEDIATE
PRELIMINARY NOTIFICATION

April 21, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE -- PNO-79-67AB

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on April 21, 1979.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

The average primary coolant temperature is being maintained at 175 degrees F by admitting steam directly to the main condensor through the main turbine. The highest incore thermocouple reading is 275 degrees F.

Train A of the Auxiliary Building Ventilation System was placed in service at 11:45 p.m. on April 20. Work is now in progress to change the charcoal filters in Train B of the Fuel Handling Building Ventilation System.

Environmental Status

Offsite radiation levels identified by NRC survey teams were consistent with normal background levels (0.02 mR/hr maximum). These results were obtained from routine surveys performed downwind on the east side of the Susquehanna River at distances up to five miles north and south of the site.

An Aerial Measuring System (AMS) survey was conducted 8:20 a.m. to 9:12 a.m. April 20, 1979. A small plume reading 0.008 mR/hr was located about 250 meters E of the Unit II vent stack at an altitude of 100 meters. Spectral analysis indicated small amount of Xenon-133. An AMS survey from 11:45 p.m. April 20 to 12:20 a.m. April 21 did not detect any airborne radioactivity. This flight occurred following the change from Filter Train B to Train A in the Auxiliary Building.

During the period from 5:30 a.m. April 20 to 5:30 a.m. April 21, seven air samples collected around the site showed no activity above the minimum detectable activity.

Dose rates (47 locations) as measured by NRC thermoluminescent dosimeters (TLDs) for the past 24-hour period are near expected natural background levels.

CONTINUED
IMMEDIATE PRELIMINARY NOTIFICATION

Iodine concentrations measured in the Unit 2 ventilation stack since PNO-79-67AA (April 20, 1979) are:

<u>Time</u>	<u>Activity (uCi/cc)</u>
4/20 (0351) - 4/20 (0820)	2.0×10^{-7}
4/20 (0820) - 4/20 (1105)	1.9×10^{-7}
4/20 (1105) - 4/20 (1300)	2.8×10^{-7}
4/20 (1300) - 4/20 (1621)	Not Analyzed
4/20 (1621) - 4/20 (2019)	1.8×10^{-7}
4/20 (2023) - 4/20 (2204)	2.3×10^{-7}
4/20 (2208) - 4/20 (2249)	3.0×10^{-7}
4/20 (2249) - 4/21 (0317)	1.1×10^{-7}
4/21 (0317) - 4/21 (0402)	7.6×10^{-8}

The NRC took the daily air sample near the observation center starting at 4:00 p.m. on April 19 and ending at 4:00 p.m. on April 20. Analysis of this sample indicated that the concentration of Iodine-131 during the 24-hour period averaged less than 1.0×10^{-12} microcuries per cubic centimeter (less than 1.0 picocuries per cubic meter).

EPA reported that of the air samples collected at 31 sampling locations on April 15 and 16 only nine showed Iodine-131 above the minimum detectable activity (MDA). The highest sample result was 2.3×10^{-12} microcuries per cubic centimeter (2.3 picocuries per cubic meter) for a sample collected April 15, 2.9 miles SSW of the plant. All other positive values were less than 4.5×10^{-13} microcuries per cubic centimeter (0.45 picocuries per cubic meter).

EPA reported that water samples taken at the plant discharges to the river on April 18, 19 and 20 and at Brunner Island on April 16, 17 and 18 downstream showed no activity above the MDA.

EPA reported no milk samples collected on April 15 or 16 contained Iodine-131 above the MDA of 15 picocuries per liter. The Pennsylvania DER reported that one sample of milk collected on April 19 at Elizabethtown contained about 15 picocuries of Iodine-131 per liter. The licensee reported that a cow's milk sample collected on April 17 contained 3.7 picocuries per liter and a goat's milk sample collected on April 16 contained 3.3 picocuries per liter. The action level is 12,000 picocuries per liter, at which time animals would be taken off pasture.

The Commonwealth of Pennsylvania has been informed of these results.

Contact: G. C. Gower, IE x27246 H. D. Thornburg, IE x28484

Distribution: Transmitted H St 10:05
Chairman Hendrie Commissioner Bradford
Commissioner Kennedy Commissioner Ahearne
Commissioner Gilinsky
Transmitted: MNBB 10:10 P. Bldg. 10:14
L. V. Gossick, EDO H. R. Denton, NRR
H. L. Ornstein, EDO R. C. DeYoung, NRR
J. J. Fouchard, PA R. J. Mattson, NRR
N. M. Haller, MPA V. Stello, NRR
R. G. Ryan, OSP R. S. Boyd, NRR
H. K. Shapar, ELD SS Bldg. 10:18
W. J. Dircks, NMSS
S. Levine, RES

S. J. Chilk, SECY
C. A. Kammerer, CA
(For Distribution)
J. G. Davis, IE
Region I 10:20
Region II 10:22
Region III 10:24
Region IV 10:42
Region V 10:26
(MAIL)
J. J. Cummings, OIA
R. Minogue, SD

IE(TMI) Site 4:00 pm (Provide copy to STATE)
White House Situation Room 11:25
FDAA 12:35 (Provide copies to the Administrator and the Operations Center)
EPA 12:02
DOE/EOC 11:30
PEMA 12:20
BRP (State of PA) 11:55
DCPA 11:30
HEW (Pickup)

IMMEDIATE
PRELIMINARY NOTIFICATION

IMMEDIATE
PRELIMINARY NOTIFICATION

April 22, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE -- PNO-79-67AC

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on April 22, 1979.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

The average primary coolant temperature is still being maintained at 175 degrees F by admitting steam directly to the main condenser through the main turbine. The highest incore thermocouple reading is 274 degrees F.

Now that Train A of the Auxiliary Building Ventilation System is in service, preparations are being made to change the filters in Train B. Work is also in progress to change the charcoal filters of Train A of the Fuel Handling Building Ventilation System. Train A was selected for replacement instead of Train B as reported in PNO-79-67AB.

Environmental Status

Onsite Measurements

Two Aerial Measuring System (AMS) surveys were conducted during the period 3:00 p.m. - 10:00 p.m. on April 21, 1979. No airborne radioactivity was detected.

Iodine concentrations at Unit 2 ventilation stack. (Analyzed by NRC Mobile Laboratory).

<u>Date/Time</u>	<u>Activity (uCi/cc)</u>
4/21 (0404) - 4/21 (0819)	5.2×10^{-8}
4/21 (0819) - 4/21 (1201)	8.0×10^{-8}
4/21 (1204) - 4/21 (1625)	8.8×10^{-8}
4/21 (1648) - 4/21 (2017)	4.9×10^{-8}
4/21 (2018) - 4/22 (0103)	1.1×10^{-7}
4/22 (0103) - 4/22 (0441)	1.1×10^{-7}

CONTINUED
IMMEDIATE PRELIMINARY NOTIFICATION

Off Site Measurements

Radiation Levels

Offsite radiation levels identified by NRC survey teams continue to be consistent with normal background levels (0.02 mR/hr maximum). These results were obtained from routine surveys performed downwind on the east and west sides of the Susquehanna River at distances up to five miles north and south of the site.

Dose rates (47 locations) as measured by NRC thermoluminescent dosimeters (TLDs) for the past 24-hour period are near expected natural background levels.

NRC Environmental Samples (Samples taken offsite within 3 miles of site - analyzed in mobile laboratory)

<u>Sample Type</u>	<u>Date of Sample</u>	<u>Number of Samples</u>	<u>Results</u>
air	4/21-22	9	Less than MDA*
daily air	4/21-22	1	Less than MDA
grass	4/20-21	2	Highest 2.4×10^{-4} microcurie per square meter
milk	4/19-20	5	Less than MDA

* MDA = minimum detectable activity

EPA Environmental Samples (Analyzed at Remote Laboratory)

<u>Sample Type</u>	<u>Date of Sample</u>	<u>Number of Samples</u>	<u>Results</u>
air	4/18	27	Less than MDA
air	4/18	4	Highest 2.9×10^{-12} microcuries per cubic centimeter (2.9 pico-curies/cubic meter)
milk	4/18	3	Less than MDA

All EPA samples were taken at distances greater than 3 miles from the site.

The Commonwealth of Pennsylvania has been informed of these results.

Contact: G. C. Gower, IE x27246 S. E. Bryan, IE x28019

Distribution: Transmitted H St 11:18
Chairman Hendrie Commissioner Bradford
Commissioner Kennedy Commissioner Ahearne
Commissioner Gilinsky
Transmitted: MNBB 11:32 P. Bldg. 11:37
L. V. Gossick, EDO H. R. Denton, NRR
H. L. Ornstein, EDO R. C. DeYoung, NRR
J. J. Fouchard, PA R. J. Mattson, NRR
N. M. Haller, MPA V. Stello, NRR
R. G. Ryan, OSP R. S. Boyd, NRR
H. K. Shapar, ELD SS Bldg. 11:41
W. J. Dircks, NMSS
S. Levine, RES
S. J. Chilk, SECY
C. A. Kammerer, CA
(For Distribution)
J. G. Davis, IE
Region I 11:45
Region II 11:49
Region III 11:54
Region IV 11:58
Region V 12:03
(MAIL)
J. J. Cummings, OIA
R. Minogue, SD
IE(TMI) Site 11:26 (Provide copy to STATE)
White House Situation Room 11:55
FDAA 8:52 (Provide copies to the Administrator and the Operations Center)
EPA 9:00 4/23
DOE/EOC 12:13
PEMA 12:21
BRP (State of PA) 10:07 4/23
DCPA 9:45 4/23
HEW (Pickup)

IMMEDIATE
PRELIMINARY NOTIFICATION

April 23, 1979

PRELIMINARY NOTIFICATION OF EVENT OR UNUSUAL OCCURRENCE -- PNO-79-67AD

This preliminary notification constitutes summary information of an event of safety or public interest significance. The information presented is a summary of information as of 7:00 a.m. on April 23, 1979.

Facility: Three Mile Island Unit 2
Middletown, Pennsylvania (DN 50-320)

Subject: NUCLEAR INCIDENT AT THREE MILE ISLAND

Plant Status

The average primary coolant temperature is still being maintained at 175 degrees F by admitting steam directly to the main condenser through the main turbine. The highest incore thermocouple reading is 272 degrees F.

The charcoal filters in Train A of the Fuel Handling Building have been replaced. This train is scheduled to be placed in service this date. This action is expected to further reduce the concentration of Iodine being released from the ventilation stack. The previous action of changing the charcoal filters in Train A of the Auxiliary Building Ventilation System was successful and reduced Iodine discharges by approximately 40 percent. Preparations are still being made to change the charcoal filters in Train B of the Auxiliary Building Ventilation System.

A pressurized primary coolant sample was taken at 11:30 a.m. on April 22, 1979 and sent to B&W Lynchburg, Va. for analysis.

Environmental Status

Onsite Measurements

No Aerial Measuring System (AMS) survey was conducted on April 22, 1979.

Iodine concentration at Unit 2 ventilation stack. (Analyzed by NRC Mobile Laboratory).

<u>Date/Time</u>	<u>Activity (uCi/cc)</u>
4/22 (0447) - 4/22 (0804)	8.8×10^{-8}
4/22 (0807) - 4/22 (1229)	9.3×10^{-8}
4/22 (1230) - 4/22 (1621)	9.6×10^{-8}
4/22 (1624) - 4/22 (2024)	1.3×10^{-7}
4/22 (2036) - 4/22 (2130)	1.3×10^{-7}
4/22 (2130) - 4/23 (0004)	9.6×10^{-8}
4/23 (0007) - 4/23 (0440)	5.9×10^{-8}

CONTINUED
IMMEDIATE PRELIMINARY NOTIFICATION

Offsite Measurements

Radiation Levels

Offsite radiation levels identified by NRC survey teams continue to be consistent with normal background levels (0.02 mR/hr maximum). These results were obtained from routine surveys performed downwind on the east side of the Susquehanna River at distances up to five miles north and south of the site.

Dose rates (47 locations) as measured by NRC thermoluminescent dosimeters (TLDs) for the past 24-hour period are near expected natural background levels.

NRC Environmental Samples (Samples taken offsite within 3 miles of site analyzed in mobile laboratory)

<u>Sample Type</u>	<u>Date of Sample</u>	<u>Number of Sample</u>	<u>Results</u>
air	4/22-23	7	Less than MDA*
daily air	4/21-22	1	Less than MDA

* MDA = minimum detectable activity

EPA Environmental Samples (Analyzed at Remote Laboratory)

<u>Sample Type</u>	<u>Date of Sample</u>	<u>Number of Sample</u>	<u>Results</u>
air	4/21	21	Less than MDA
air	4/21	10	Highest 8.6×10^{-13} microcuries per cubic centimeter (.86 picocuries per cubic meter)
air	4/21	2	118 picocuries per cubic meter of Xe-133 in one sample. 20 and 24 picocuries per cubic meter Kr-85.** These are approximately background levels.
Soil	4/21	31	Nothing above natural background
Vegetation	4/21	31	Nothing above natural background

All EPA samples were taken at distances greater than 2 miles from the site.

** Maximum Permissible Concentration for Xe-133 and Kr-85 is 300,000 picocuries per cubic meter.

The Commonwealth of Pennsylvania has been informed of these results.

Contact: RCPaulus, IE x27246 DThompson, IE x28487

Distribution: Transmitted H St 12:00

Chairman Hendrie
Commissioner Kennedy
Commissioner Gilinsky

Commissioner Bradford
Commissioner Ahearne

S. J. Chilk, SECY
C. C. Kammerer, CA
(For Distribution)

Transmitted: MNBB 12:04

L. V. Gossick, EDO
H. L. Ornstein, EDO
J. J. Fouchard, PA
N. M. Haller, MPA
R. G. Ryan, OSP
H. K. Shapar, ELD

P. Bldg 12:19
H. R. Denton, NRR
R. C. DeYoung, NRR
R. J. Mattson, NRR
V. Stello, NRR
R. S. Boyd, NRR
SS Bldg 12:09
W. J. Dircks, NMSS
S. Levine, RES

J. G. Davis, IE
Region I 1:31
Region II 1:36
Region III 1:24
Region IV 1:44
Region V 1:03
(MAIL)
J. J. Cummings, OIA
R. Minogue, SD

IE (TMI) Site 12:41 (Provide copy to STATE)

White House Situation Room ~~3:20~~

FDA 1:30 (Provide copies to the Administrator and the Operations Center)

EPA 2:10

DOE/EOC 2:15

PEMA 2:39

BRP (State of PA) ~~3:30~~

D CPA 3:30

HEW (Pickup)

IMMEDIATE
PRELIMINARY NOTIFICATION

RM

TMI CLEANUP

BY JEFF BARKER

WASHINGTON (AP) -- SEVENTY PERCENT OF THE MATERIAL INSIDE THE CORE OF THE CRIPPLED THREE MILE ISLAND NUCLEAR REACTOR MAY HAVE LIQUEFIED DURING THE MARCH 1979 ACCIDENT, SAYS A GOVERNMENT SCIENTIST.

THE LIQUEFIED MATERIAL INCLUDED FUEL, PARTS OF THE CORE STRUCTURE AND THE TUBES IN WHICH THE FUEL IS CONTAINED, SAID DON MCPHERSON, A DEPARTMENT OF ENERGY OFFICIAL WHO MANAGES THE TMI UNIT-2 ACCIDENT EVALUATION PROGRAM.

HIS REMARKS CAME DURING AN INTERVIEW IN WHICH HE EXPANDED ON A PRESENTATION TUESDAY TO THE NUCLEAR REGULATORY COMMISSION. THE COMMISSION HAS BEEN MONITORING THE \$1 BILLION TMI CLEANUP.

MCPHERSON SAID BETWEEN 5 PERCENT AND 10 PERCENT OF THE FUEL MELTED AFTER REACHING A TEMPERATURE OF 5,100 DEGREES. MUCH MORE -- PERHAPS 60 PERCENT -- BEGAN TO DISSOLVE AND MELD WITH A METALLIC ELEMENT IN THE CORE AFTER REACHING 3,050 DEGREES, HE SAID.

MCPHERSON'S ESTIMATES CAME 13 MONTHS AFTER THE FIRST PUBLIC DISCLOSURE THAT URANIUM FUEL HAD MELTED DURING THE ACCIDENT. PREVIOUS STUDIES INDICATED ONLY THAT SOME METAL PARTS IN THE CORE HAD MELTED.

INDUSTRY CRITICS AND OPPONENTS OF THE NUCLEAR INDUSTRY SAID THE 1985 FINDING MEANT THE ACCIDENT WAS MORE SEVERE THAN HAD BEEN BELIEVED.

GENERAL PUBLIC UTILITIES NUCLEAR CORP., WHICH OPERATES THE PLANT NEAR HARRISBURG, PA., HAS REFUSED TO ESTIMATE HOW MUCH FUEL OR CORE MATTER MELTED.

ASKED ABOUT MCPHERSON'S REMARKS, GPU NUCLEAR SPOKESMAN DOUG BEDELL SAID HE DID NOT KNOW HOW MUCH OF THE FUEL OR CORE MATERIAL MELTED.

"WE DON'T HAVE COMPLETE ACCESS," HE SAID.

AP-WX-03-12-86 1600EST

From: [Correia, Richard](#)
To: [Uhle, Jennifer](#)
Subject: Accepted: Discuss FOIA (Japan Requirements)

YX/543

From: Correia, Richard
To: Janney, Margie
Subject: Declined: Revised With Bridge line Info.- Request for Information after Events in Japan

Working the mid shift in the ops center

YY/544

From: Correia, Richard
To: Janney, Margie
Subject: Declined: Request for Information after Events in Japan

On shift in the ops center

44/545

Nuclear Power Plants and Earthquakes
<http://www.world-nuclear.org/info/inf18.html>

- **Japanese, and most other, nuclear plants are designed to withstand earthquakes, and in the event of major earth movement, to shut down safely.**
- **In 1995, the closest nuclear power plants, some 110 km north of Kobe, were unaffected by the severe Kobe-Osaka earthquake, but in 2004, 2005, 2007 and 2009 Japanese reactors shut down automatically due to ground acceleration exceeding their trip settings.**
- **In 1999, three nuclear reactors shut down automatically during the devastating Taiwan earthquake, and were restarted two days later.**

Design criteria

Nuclear facilities are designed so that earthquakes and other external events will not jeopardise the safety of the plant. In France for instance, nuclear plants are designed to withstand an earthquake twice as strong as the 1000-year event calculated for each site. It is estimated that, worldwide, 20% of nuclear reactors are operating in areas of significant seismic activity.

Because of the frequency and magnitude of earthquakes in Japan, particular attention is paid to seismic issues in the siting, design and construction of nuclear power plants. The seismic design of such plants is based on criteria far more stringent than those applying to non-nuclear facilities. Power reactors are also built on hard rock foundations (not sediments) to minimise seismic shaking.

Japanese nuclear power plants are designed to withstand specified earthquake intensities evident in ground motion. These used to be specified as S1 and S2, but now simply Ss, in Gal units. The plants are fitted with seismic detectors. If these register ground motions of a set level (formerly 90% of S1), systems will be activated to automatically bring the plant to an immediate safe shutdown. The logarithmic Richter magnitude scale (or more precisely the Moment Magnitude Scale more generally used today) measures the overall energy released in an earthquake, and there is not always a good correlation between that and intensity (ground motion) in a particular place. Japan has a seismic intensity scale in shindo units 0 to 7, with weak/strong divisions at levels 5 & 6, hence ten levels. This describes the surface intensity at particular places, rather than the magnitude of the earthquake itself.

The revised seismic regulations released in May 2007 increased the Ss figure to be equivalent to 6.7 on the Richter or Moment Magnitude scale - a factor of 1.5 (up from a magnitude of 6.5). PGA is measured in Galileo units - Gal (cm/sec^2) or g - the force of gravity, one g being 980 Gal.

The design basis earthquake ground motion or peak ground acceleration (PGA) S1 was defined as the largest earthquake which can reasonably be expected to occur at the site of

47/546

a nuclear power plant, based on the known seismicity of the area and local active faults. A power reactor could continue to operate safely during an S1 level earthquake, though in practice they are set to trip at lower levels. If it did shut down, a reactor would be expected to restart soon after an S1 event. The revised seismic regulations released in May 2007 increased the S1 figure to be equivalent to 6.7 on the logarithmic Richter scale - a factor of 1.5 (up from 6.5). PGA is measured in Galileo units - Gal (cm/sec²) or g - the force of gravity, one g being 980 Gal. The non-SI unit is used here.

Larger earthquake ground motions (PGAs) in the region, considering the tectonic structures and other factors, must also be taken into account, although their probability is very low. The largest conceivable such ground motion was the upper limit design basis extreme earthquake ground motion (PGA) S2, generally assuming a magnitude 6.5 earthquake directly under the reactor. The plant's safety systems would be effective during an S2 level earthquake to ensure safe shutdown without release of radioactivity, though extensive inspection would be required before restart. In particular, reactor pressure vessel, control rods and drive system and reactor containment should suffer no damage at all.

After the magnitude 7.2 Kobe earthquake in 1995 a panel was set up to review the safety of nuclear facilities in Japan and the design guidelines for their construction. The Japanese Nuclear Safety Commission (NSC) then approved the panel's report. Building and road construction standards were also thoroughly reviewed at this time. After recalculating the seismic design criteria required for a nuclear power plant to survive near the epicentre of a large earthquake the NSC concluded that under current guidelines such a plant could survive a quake of magnitude 7.75. The Kobe earthquake was 7.2.

Japan's Rokkasho reprocessing plant and associated facilities are built on stable rock and are designed to withstand an earthquake of magnitude 8.25.

Following a magnitude 7.3 earthquake in 2000 in an area where no geological fault was known, Japan's NSC ordered a full review of the country's 1978 seismic guidelines (which had been adopted by the NSC in 1981 and partially revised in 2001). This reported in 2006 and resulted in NSC and the Nuclear & Industrial Safety Agency (NISA) calling for reactor owners with NISA to undertake plant-specific reviews of seismic safety, to be completed in 2008. The main result of this review was that the S1 – S2 system was formally replaced by NSC in September 2006 with a single Design Basis Earthquake Ground Motion (DBGM Ss). The main reactor facilities "shall maintain their safety functions under the seismic force caused by DBGM Ss." They and ancillary facilities should also withstand the "seismic force loading of those caused by Elastically Dynamic Design Earthquake Ground Motion Sd (EDGM Sd)" calculated from stress analysis and being at least half the Ss figure.

In March 2008 Tepco upgraded its estimates of likely PGA for Fukushima to 600 Gal, and other operators have adopted the same figure. In October 2008 Tepco accepted 1000 Gal (1.02g) PGA as the new Ss design basis for Kashiwazaki Kariwa, following the July 2007 earthquake there.

Japanese nuclear plants such as Hamaoka near Tokai are in regions where earthquakes of up to magnitude 8.5 may be expected. In fact the Tokai region has been racked by very major earthquakes about every 150 years, and it is 155 years since the last big one. Chubu's Hamaoka reactors were designed to withstand such anticipated Tokai earthquake and had design basis S1 of 450 Gal and S2 of 600 Gal. Units 3 & 4 were originally designed for 600 Gal, but the Ss standard established in September 2007 required 800 Gal. Since then units 3-5 have been upgraded to the new Ss standard of 1000 Gal. In August 2009 a magnitude 6.5 earthquake nearby automatically shut down Hamaoka 4 & 5, with ground motion of 426 Gal being recorded at unit 5. Some ancillary equipment was damaged and reactors 3 and 4 were restarted after checking. Restart of unit 5 was repeatedly deferred as the company analysed why such high seismic acceleration was recorded on it, coupled with some planned maintenance being undertaken during the shutdown. It restarted in January 2011.

Hamaoka units 1 & 2 had been shut down since 2001 and 2004 respectively, pending seismic upgrading – they were originally designed to withstand only 450 Gal. In December 2008 the company decided to write them off and build a new reactor to replace them. Modifying the two 1970s units to new seismic standards would have cost about US\$ 3.3 billion and been uneconomic, so Chubu opted for a US\$ 1.7 billion write-down instead.

Early in 2010 Japan's METI confirmed that the seismic safety of the Monju fast reactor was adequate under new standards requiring Ss of 760 Gal PGA. Assessments were carried out in conjunction with Kansai's Mihama plant and JAPC's Tsuruga plant, both nearby.

South Korea's new APR-1400 reactor is designed to withstand 300 Gal seismic acceleration. The older OPR is designed for 200 Gal but is being upgraded to at least 300 Gal so as to be offered to Turkey and Jordan.

Japan 1995 - Kobe

Newspaper coverage of the magnitude 7.2 Kobe earthquake which devastated Kobe and the surrounding region on 17 January 1995 raised concerns about the safety of nuclear power plants in the affected area. Horizontal ground acceleration was measured at 817 Gal – more intense than expected - and vertical acceleration was 332 Gal.

In fact none of the power reactors within 200 km of the earthquake epicentre sustained any damage and those running at the time continued to operate at capacity. Takahama and Ohi are located approximately 130 km from the epicentre of the earthquake, on the Pacific Ocean side of the Island of Honshu. Mihama is approximately 180 km away. The research reactors in the region, in Osaka and Kyoto, were also reported to be unaffected by the earthquake.

Taiwan 1999 - Chichi

The shallow magnitude 7.6 earthquake in central Taiwan on 21 September 1999 killed thousands of people. It caused three reactors at Chinshan and Kuosheng in the north of the island to shut down automatically. They were cleared to restart two days later. A fourth reactor there was being refuelled. The two reactors at Maanshan in the south continued operating, but reduced power later due to damage to distribution facilities. A major concern following the earthquake was how quickly power could be restored to industry.

Japan 2005 - Miyagi

On 16 August 2005 Tohoku's three Onagawa reactors shut down automatically when a magnitude 7.2 earthquake hit northeast Honshu. They were set to trip at 200 Gal, against S1 design basis of 250 Gal (which was reached) and S2 PGA of 350-400 Gal. No damage occurred in any major part of the plant.

Onagawa-2 restarted in January 2006 after comprehensive checks and confirming that an S2 figure of 580 Gal would be safe for that unit (equivalent to magnitude 8.2). Geotechnical analysis and safety evaluation proceeded under NISA, which approved a report from the company. Unit 3 restarted in March 2006, and the smaller unit 1 restarted in May 2007.

Japan 2007 - Niigataken Chuetsu-Oki

On 16 July 2007 the magnitude 6.8 Niigata Chuetsu-Oki earthquake occurred with epicentre only 16 km from Tepco's Kashiwazaki Kariwa 7965 MWe nuclear power plant. Local geological factors contributed to a magnification of the seismic intensity at the plant. The plant's seismometers measured PGA of 270 to 680 Gal (a later report said 829 Gal for unit 1), the S1 design bases for different units being 170 to 270 Gal and the S2 figure about 450 Gal. The peak ground acceleration thus exceeded the S1 design values in all units - hence the need to shut down, and the S2 values in units 1, 2 and 4. Four reactors shut down automatically at the pre-set level of 120 Gal, another three were not operating at the time. All the functions of shutdown and cooling worked as designed.

While there were many incidents on site due to the earthquake, none threatened safety and the main reactor and turbine units were structurally unaffected. Analysis of primary cooling water confirmed that there was no damage to the fuel in reactor cores. However, the plant remained closed until full investigation was complete and safety confirmed, about mid 2008. It appears that the four older units may have been more vulnerable than units 5-7 which are located 1.5 km further away.

The Ministry of Economy Trade & Industry (METI) then set up a 20-member Chuetsu Investigation and Countermeasures Committee to investigate the specific impact of this earthquake on the power station, and in the light of this to identify what government and utilities must address to ensure nuclear plant safety. It acknowledged that the government was responsible for approving construction of the first Kashiwazaki Kariwa units in the 1970s very close to what is now perceived to be a geological fault line. NISA

invited the International Atomic Energy Agency to join it, the Nuclear Safety Commission and Tepco in reviewing the situation. A report was presented to the IAEA Senior Regulators' Meeting in September 2007, and a further IAEA visit was made early in 2008.

NISA released its assessment of the safety significance of earthquake damage in November. The worst of the damage rated zero on the International Nuclear Event Scale (INES), having no safety significance. Other damage was deemed not relevant to nuclear safety. The seven main reactor units themselves were still being checked, but appeared undamaged. In May 2008 Tepco adopted a new standard of 2280 Gal (2.33g) maximum design basis seismic motion for Kashiwazaki Kariwa units 1-4, over five times the previous S2 figure, and 1156 Gal (1.18g) for units 5-7, in the light of local geological factors. This standard will be reviewed by NISA and NSC. Meanwhile construction works will be undertaken to bring all units up to be able to withstand a quake producing PGA of 1000 Gal.

Tepco posted a loss of JPY 150 billion (US\$ 1.68 billion) for FY2007 (to 31/3/08) due to the prolonged closure of the plant, followed by JPY 109 billion loss in the first half of FY2008. While no damage to the actual reactors has been found, detailed checks continue, and upgrading of earthquake resistance is required. Major civil engineering works are also required before the reactors resume operation. Overall, the FY2007 impact of the earthquake was projected to be JPY 603.5 billion (\$5.62 billion), three quarters of that being increased fuel costs to replace the 8000 MWe of lost capacity. NISA approved the utility's new seismic estimates in November 2008, and conducted final safety reviews of the units as they were upgraded. Unit 7 restarted in May, unit 6 in August 2009, unit 1 in May 2010, and unit 5 in November 2010. Units 2, 3, & 4 remain shut down.

Other experience

Earthquakes have previously occurred in the vicinity of a number of Japanese and other power reactors without adverse effect.

An earthquake registering 6.2 on Richter scale occurred offshore Fukushima in northern Japan on 13 June 2010. At the nearest coastal cities it registered 5 on the Japanese shindo scale. The nearest nuclear power plants (13 reactors): Fukushima I & II and Onagawa were unaffected. The horizontal ground acceleration reached 60 Gal at reactor building base mats at Fukushima-I.

In two decades to 2004, no Japanese reactor had been tripped by the seismic detectors. In those cases where the plant automatically shutdown ("tripped") as a safety precaution, it was because of the impact of the earthquake on the operating characteristics of the plant.

In November 1993, a magnitude 5.8 earthquake in northeast Honshu produced a ground acceleration of 121 Gal at Tohoku's Onagawa-1 power reactor (497 MWe, BWR), located 30 km from the epicentre. The design conditions for the S1 and S2 events at the site were

250 and 375 Gal respectively and the reactor was set to trip at a measured peak ground acceleration (PGA) of 200 Gal. In fact it tripped at a lower level due to variations in the neutron flux outside the set parameters.

In May 2003 a magnitude 7.1 earthquake further from the same Onagawa plant produced ground acceleration of 225 Gal which tripped unit 3 (units 1 & 2 were not operating).

In October 2004 a magnitude 6.8 earthquake in Niigata Prefecture 250 km north of Tokyo had no effect on the nearby Kashiwazaki Kariwa nuclear plant, but a magnitude 5.2 quake there two weeks later caused one of the reactors - unit 7 -to trip.

In March 2005 a magnitude 7.0 earthquake in northern Kyushu did not affect the nearby Genkai and Sendai nuclear plants, nor Shimane and Ikata.

The magnitude 7.8 earthquake off the coast of Hokkaido in July 1993, had no effect on nuclear facilities. Tomari 1 and 2 reactors (550 MWe, PWRs), located 95 km from the epicentre, continued normal operation.

In December 1994, a magnitude 7.5 earthquake struck northern Japan but caused no damage to the 11 boiling water reactors or the nuclear fuel facilities in the vicinity. All operated normally.

Reactors of both western and Soviet design have been subjected to major seismic activity in North America and Europe without damage. California's power reactors, San Onofre 2 and 3 (1,070 and 1,080 MWe, PWRs) and Diablo Canyon 1 and 2 (1,073 MWe and 1,087 MWe, PWRs) continued to operate normally during the 6.6 magnitude earthquake in January 1994. San Onofre, the closer station, was about 112 km from the epicentre.

In December 1988, a magnitude 6.9 earthquake, resulting in the deaths of at least 25,000 people, occurred in northwestern Armenia. It was felt at the two-unit Armenian nuclear power station located approximately 75 km south of the epicentre, but both Soviet-designed PWRs operated normally and no damage was reported. This was the first Russian nuclear power plant specifically adapted for seismic areas, and it started operating in 1976.

In May 2008 a magnitude 7.9 earthquake affected southwestern Sichuan province in central China. The main nuclear facilities affected were military ones, apparently without any radioactive releases. About 250 km from the epicentre the Yibin fuel fabrication plant which produces both power reactor and research reactor fuel assemblies was undamaged. China's power reactors were all at least 900 km from the epicentre.

Tsunamis

Large undersea earthquakes often cause tsunamis - pressure waves which travel very rapidly across oceans and become massive waves over ten metres high when they reach shallow water, then washing well inland. The December 2004 tsunamis following a

magnitude 9 earthquake in Indonesia reached the west coast of India and affected the Kalpakkam nuclear power plant near Madras/Chennai. When very abnormal water levels were detected in the cooling water intake, the plant shut down automatically. It was restarted six days later.

Even for a nuclear plant situated very close to sea level, the robust sealed containment structure around the reactor itself would prevent any damage to the nuclear part from a tsunami, though other parts of the plant might be damaged. No radiological hazard would be likely.

Sources:

paper originally prepared by Nuclear Services Section, External Affairs, ANSTO;

Nuclear Safety Commission Sept 2006, Regulatory Guide for Reviewing Seismic Design of Nuclear Power Reactor Facilities < <http://www.nsc.go.jp/english/taishin.pdf>>

JAIF

Tepco



This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

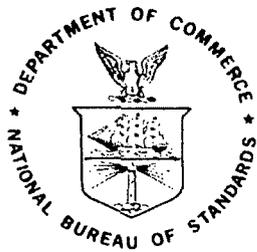
We also ask that you:

- + *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.
- + *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.
- + *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.
- + *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at <http://books.google.com/>

44/547



NBS SPECIAL PUBLICATION **592**

247

15149

DOC 77-0115

U.S. DEPARTMENT OF COMMERCE / National Bureau of Standards

An Investigation of the
Miyagi-ken-oki, Japan, Earthquake
of June 12, 1978

UNIVERSITY OF MICHIGAN



3 9015 07758 8526

Digitized by Google

NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards¹ was established by an act of Congress on March 3, 1901. The Bureau's overall goal is to strengthen and advance the Nation's science and technology and facilitate their effective application for public benefit. To this end, the Bureau conducts research and provides: (1) a basis for the Nation's physical measurement system, (2) scientific and technological services for industry and government, (3) a technical basis for equity in trade, and (4) technical services to promote public safety. The Bureau's technical work is performed by the National Measurement Laboratory, the National Engineering Laboratory, and the Institute for Computer Sciences and Technology.

THE NATIONAL MEASUREMENT LABORATORY provides the national system of physical and chemical and materials measurement; coordinates the system with measurement systems of other nations and furnishes essential services leading to accurate and uniform physical and chemical measurement throughout the Nation's scientific community, industry, and commerce; conducts materials research leading to improved methods of measurement, standards, and data on the properties of materials needed by industry, commerce, educational institutions, and Government; provides advisory and research services to other Government agencies; develops, produces, and distributes Standard Reference Materials; and provides calibration services. The Laboratory consists of the following centers:

Absolute Physical Quantities² — Radiation Research — Thermodynamics and Molecular Science — Analytical Chemistry — Materials Science.

THE NATIONAL ENGINEERING LABORATORY provides technology and technical services to the public and private sectors to address national needs and to solve national problems; conducts research in engineering and applied science in support of these efforts; builds and maintains competence in the necessary disciplines required to carry out this research and technical service; develops engineering data and measurement capabilities; provides engineering measurement traceability services; develops test methods and proposes engineering standards and code changes; develops and proposes new engineering practices; and develops and improves mechanisms to transfer results of its research to the ultimate user. The Laboratory consists of the following centers:

Applied Mathematics — Electronics and Electrical Engineering² — Mechanical Engineering and Process Technology² — Building Technology — Fire Research — Consumer Product Technology — Field Methods.

THE INSTITUTE FOR COMPUTER SCIENCES AND TECHNOLOGY conducts research and provides scientific and technical services to aid Federal agencies in the selection, acquisition, application, and use of computer technology to improve effectiveness and economy in Government operations in accordance with Public Law 89-306 (40 U.S.C. 759), relevant Executive Orders, and other directives; carries out this mission by managing the Federal Information Processing Standards Program, developing Federal ADP standards guidelines, and managing Federal participation in ADP voluntary standardization activities; provides scientific and technological advisory services and assistance to Federal agencies; and provides the technical foundation for computer-related policies of the Federal Government. The Institute consists of the following centers:

Programming Science and Technology — Computer Systems Engineering.

¹Headquarters and Laboratories at Gaithersburg, MD, unless otherwise noted; mailing address Washington, DC 20234.

²Some divisions within the center are located at Boulder, CO 80303.

C 13.001.502

An Investigation of the Miyagi-ken-oki, Japan, Earthquake of June 12, 1978

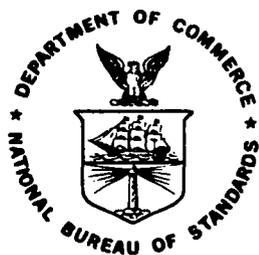
Issued under the auspices of the United States—Japan Program
in Natural Resources (UJNR) Panel on Wind and Seismic Effects

Bruce R. Ellingwood, Editor

Center for Building Technology
National Engineering Laboratory
National Bureau of Standards
Washington, DC 20234

Contributing authors:

A. Gerald Brady, U.S. Geological Survey, Menlo Park, CA
James D. Cooper, Federal Highway Administration, Washington, DC
Bruce R. Ellingwood, National Bureau of Standards, Washington, DC
Hugh H. Fowler, Federal Emergency Management Agency, Bethell, WA
Edwin L. Harp, U.S. Geological Survey, Menlo Park, CA
David K. Keefer, U.S. Geological Survey, Menlo Park, CA
Carl M. Wentworth, U.S. Geological Survey, Menlo Park, CA
Peter I. Yanev, URS/John A. Blume & Associates, San Francisco, CA



U.S. DEPARTMENT OF COMMERCE, Philip M. Klutznick, Secretary

Luther H. Hodges, Jr., Deputy Secretary

Jordan J. Baruch, Assistant Secretary for Productivity, Technology and Innovation

NATIONAL BUREAU OF STANDARDS, Ernest Ambler, Director

Issued October 1980

Library of Congress Catalog Card Number: 80-600116

National Bureau of Standards Special Publication 592

Nat. Bur. Stand. (U.S.), Spec. Publ. 592, 232 pages (Oct. 1980)

CODEN: XNBSAV

U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON: 1980

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402

Price \$6.50

(Add 25 percent for other than U.S. mailing)

FOREWORD

I am very pleased that a report on the investigation of the Miyagi-ken-oki, Japan earthquake of June 12, 1978, has been prepared by U.S. engineers and scientists as an activity of the joint program of the UJNR Panel on Wind and Seismic Effects.

I hope this report will play an important role not only in improving understanding of the Miyagi-ken-oki earthquake and other circumstances about earthquakes in Japan but also in contributing to the earthquake research of your country.

Through the field survey conducted by U.S. members at the sites where damage occurred from this earthquake, the importance of cooperating research activities in our panel was reaffirmed.

Finally, I deeply respect the effort to compile the report and hope our relationship will continue.

Yoshihiro Sakagami, Chairman (Japan)
UJNR Panel on Wind and Seismic Effects
Director General
Public Works Research Institute
Ministry of Construction

A part of the mission of the U.S.-Japan Panel on Wind and Seismic Effects of UJNR* is to carry out joint projects on the investigation of natural disasters. Immediately after the Miyagi-ken-oki, Japan earthquake of June 12, 1978, a team of U.S. panel members and other engineers and scientists was dispatched to Miyagi Prefecture. The investigation was coordinated by members of the Japan Panel on Wind and Seismic Effects.

This document is the result of the investigation by the U.S. team on the earthquake. It describes geologic features of the earthquake-stricken area, and damage to human-made structures. It is hoped the information presented in this document will add to the knowledge of seismology and earthquake engineering.

The U.S. Panel expresses its sincere appreciation to the Japan Panel for their cooperation in arranging the investigation and the fullest assistance given to the U.S. team. We look forward to the continuation of these cooperative efforts.

Edward O. Pfrang, Chairman (U.S.)
UJNR Panel on Wind and Seismic Effects
Center for Building Technology
National Bureau of Standards

* U.S.-Japan Cooperative Program in Natural Resources

ABSTRACT

On June 12, 1978, a destructive earthquake with Richter magnitude of 7.4 occurred off the east coast of Miyagi Prefecture, Japan. Preliminary estimates by the National Land Agency of Japan indicated that the earthquake caused an equivalent of \$800 million in total damage. There is a cooperative agreement between the governments of the United States and Japan termed the U.S.-Japan Program in Natural Resources (UJNR). Following the earthquake, it was arranged through UJNR that teams of U.S. structural engineers and geologists would visit Miyagi Prefecture and inspect the damage caused by the earthquake. This report assembles the information and collective experiences of the investigation team so as to describe the earthquake and document its effects. Field investigations conducted by geologists and structural engineers are described in detail and some of the implications for seismic resistant design and construction of structures in the United States are also discussed.

Key Words: Bridges; buildings; dikes; earthquakes; foreign engineering; geology; highways; housing; landslides; liquefaction; power plants; railroads; rockslides; seismicity; structural engineering.

Table of Contents

	<u>Page</u>
1. Introduction	1
1.1 General Situation	1
1.2 Acknowledgments	3
2. Social Effects and Government Response	4
2.1 Damage	4
2.2 Response	8
2.3 Reconstruction	10
2.4 Insurance	10
2.5 Conclusions	11
3. Tectonic and Geologic Setting	12
3.1 Introduction	12
3.2 Tectonic Setting	12
3.3 Seismic Gap and Precursors	19
3.4 Miyagi-ken-oki Earthquake of June 12	22
3.5 Location of Energy Source	25
3.6 Geology of the Damage Region	25
3.7 References	33
4. Strongmotion Records and Data	36
4.1 Introduction	36
4.2 The SMAC Accelerograph	36
4.3 Acceleration Records at Ground Level	37
4.4 Intensities	40
4.5 Records from Structures	43
4.6 A Comparison with Recorded Results of the San Fernando Earthquake 1971	47
4.7 Tohoku University Engineering Building	48
4.8 Tracing of Records	48
4.9 References	48
5. Earthquake Performance of Buildings	61
5.1 Introduction	61
5.2 Seismic Engineering and Construction Practice	61
5.3 Commercial and Retail Establishments	71
5.4 Schools	96
5.5 Residences	113
5.6 Summary	117
5.7 References	117
6. Effects to Industrial Facilities and Lifelines	120
6.1 Introduction	120
6.2 Fukushima Nuclear Power Plant Complex	120
6.3 New Sendai Power Plant, Tohoku Electric Power Company	123
6.4 Sendai Substation, Tohoku Electric Power Company	132
6.5 Haranomachi Plant of Sendai City Gas Bureau	137
6.6 Sendai Refinery, Tohoku Oil Co., Ltd.	137
6.7 Concrete Batch Plant, Sendai	154

	<u>Page</u>
7. Earthquake Performance of Transportation Lifelines	158
7.1 Introduction	158
7.2 Bridge Design Criteria	158
7.3 Bridge Damage	159
7.4 Highway Damage	186
7.5 Railroad Damage	186
7.6 Tunnel Performance	190
7.7 Conclusion	190
7.8 References	190
8. Liquefaction and Damage to Dikes	195
8.1 Introduction	195
8.2 Summary of Dike Damage	195
8.3 Geologic Setting	195
8.4 Field Observations of Dike Damage	198
8.5 Liquefaction in the Port of Ishinomaki	206
8.6 Conclusion	206
8.7 References	206
9. Seismic-Induced Landslides	209
9.1 Introduction	209
9.2 Rock falls and Rock slides in Natural Slopes	209
9.3 Rock falls and Rock slides in Cut Slopes	213
9.4 Landslides in Artificial Fill	219
9.5 Summary of Findings	223
9.6 References	223
10. General Conclusions	224

1. INTRODUCTION

1.1 GENERAL SITUATION

Sendai City, located in Miyagi Prefecture, Japan, is a modern industrial and commercial city located some 350 km northeast of Tokyo (Figure 1.1). Miyagi Prefecture has a population of about 1.9 million, of which approximately 600,000 reside in Sendai City. Another million are found in the suburbs of Sendai or in nearby cities and villages. This section of Japan is quite mountainous, and the population is restricted to coastal plains and mountain valleys. The population density is much more concentrated than in the United States. For instance, Sendai City occupies an area that is probably about one-third the size of Seattle, Washington, which has a similar population. There are about 6,500 business/manufacturing firms in Miyagi Prefecture and about 452,000 households (homes and apartments). Critical facilities within the area of damage include police, fire, power plants (nuclear and fossil fuel), oil and gas processing and storage, dams, hospitals, schools, and prefectural and municipal buildings.

On Monday, June 12, 1978, at 1714 hours local time, a destructive earthquake with Richter magnitude of 7.4 occurred off the east coast of Miyagi Prefecture. The earthquake hypocenter was located at 38° 9'N latitude, 142° 13'E longitude, at a depth of 30 km. This places the epicenter at a point approximately 120 km ESE from Sendai City and 95 km SE of the fishing town of Ishinomaki. The distance to the nearest instrumented recordings is about 70 km. Historically, this is a seismically active area; in fact, an earthquake of Richter magnitude 6.7 occurred as recently as February 20, 1978. Although the effects were felt as far away as Tokyo, where a window fell from a new high-rise building, major damage was confined primarily to Miyagi Prefecture. The intensity of ground shaking was reported to be V on the Japan Meteorological Agency (JMA) scale in an area approximately 180 km by 60 km along the coast which includes the cities of Ofunato, Ishinomaki, Shiogama, Sendai, and Fukushima. JMA intensity V is approximately equivalent to a Modified Mercalli intensity in the range VII-VIII. It is partially described as "Very strong - cracks in walls, overturning of tombstones and stone lanterns; damage to masonry chimneys and mud-plastered warehouses." The main earthquake was preceded by a smaller shock at 1703 hours; several aftershocks were felt during the following 4 days.

As of July 1, 1978, 27 deaths had been attributed to the earthquake in Miyagi Prefecture, of which 17 were caused by collapsing walls; nearly 1,600 people were injured. Electrical power was lost in Sendai for approximately 6 hours, and was not completely restored for several days. Damage to the natural gas distribution system upon which much of the city relies was a significant problem, and some areas of Sendai were still without gas 2 weeks following the earthquake. Other critical services were disrupted, but not to the extent that disaster recovery operations could not begin immediately following the earthquake. Preliminary estimates by the National Land Agency indicate that the earthquake caused an equivalent of about \$800 million in total damage.

There exists, between the Governments of the United States and Japan, a cooperative agreement termed the U.S.-Japan Program in Natural Resources (UJNR). The principals for the UNJR Panel on Wind and Seismic Effects are the U.S. National Bureau of Standards (NBS) and the Public Works Research Institute (PWRI) of the Japanese Ministry of Construction. Other Government agencies are also involved in the program, including the U.S. Geological Survey and Federal Highway Administration on the U.S. panel and the Building Research Institute and the National Research Center for Disaster Prevention on the Japanese panel. Following the earthquake, it was arranged through UJNR that teams of U.S. structural engineers and geologists should visit Miyagi Prefecture and inspect the damage. Concurrently, the Federal Disaster Assistance Administration arranged for the visit of their representative through the American Embassy in Tokyo.

Team members traveled as individuals or as groups as their interests and circumstances dictated. Mr. Brady arrived June 19th and spent 2 days in the Sendai area viewing general damage. Messrs. Cooper, Ellingwood, and Yanev arrived on June 22nd and spent 5 days in Miyagi Prefecture inspecting damage to buildings, industrial facilities, and transportation structures. Messrs. Harp, Keefer, and Wentworth arrived on June 23rd; their primary interests were in geology, seismicity, liquefaction and dike damage, and landslides and rock falls. Mr. Fowler arrived on June 24th to investigate the social effects of the earthquake and how the Japanese authorities responded to the disaster.

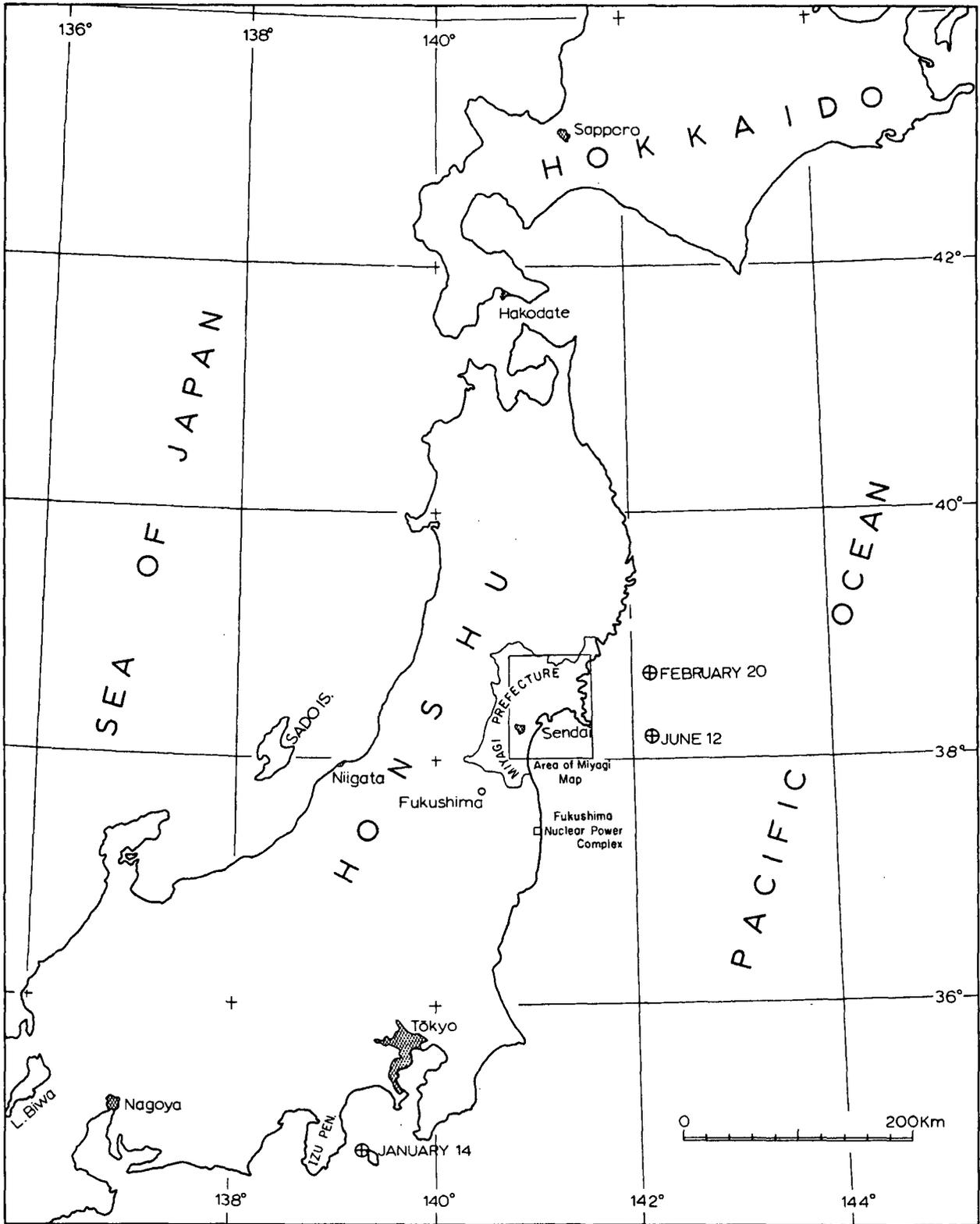


Figure 1.1 Map of Japan showing locations of Miyagi Prefecture, Sendai City and epicenters of 1978 earthquakes.

The purpose of this report is to assemble the information and collective experiences of the team members so as to describe the earthquake and document its effects. The field investigations conducted by geologists and structural engineers are described in detail, and some of the implications for the seismic resistant design and construction of structures in the United States are discussed.

1.2 Acknowledgments

The investigation of the Off-Miyagi earthquake would not have been possible without the assistance of numerous Japanese engineers, geologists, and Government officials who handled logistics and provided U.S. team members with unpublished data. Thanks first of all are due to Mr. Kazuto Nakazawa, former Director-General of the Public Works Research (PWRI) and former Chairman of the Japan panel of UJNR, for enabling us to work with his staff at a very busy and inopportune time for them. In particular, Dr. Tadayoshi Okubo, former Director of the Planning and Research Administration Division within PWRI and now Assistant Director-General, who also served as secretary for the Japan Panel of UJNR, arranged itineraries, made travel arrangements within Japan, arranged meetings with Japanese engineers and geologists, and facilitated entrance to sites of damage that otherwise would have been inaccessible. Mr. Toshio Iwasaki, Head of the Ground Vibration Division in PWRI, accompanied Messrs. Cooper, Ellingwood and Yanev on their field investigation trip to Fukushima, Sendai and Ishinomaki, while Dr. Masamitsu Ohashi, former Director of the Earthquake Disaster Prevention Department of PWRI, accompanied Mr. Brady for 2 days. Mr. Toyokazu Shimizu of the Tohoku Regional Construction Bureau spent 2 days escorting team members to sites of damaged buildings in Sendai City while Mr. Kunimatsu Hoshihata of the same Bureau hosted the visit to Ishinomaki. Representatives from the U.S. Geological Survey were hosted by Mr. Tadayuki Tazaki and were accompanied to Miyagi Prefecture by Mr. Eiichi Kuribayashi, both of the Earthquake Engineering Division, PWRI.

Dr. Hiroshi Tanaka of Tokyo Electric Power Company conducted the tour of the Fukushima power plant and later was available for discussions in Tokyo. Dr. Shinsuke Nakata of the Structural Engineering Division, Building Research Institute, was available for discussion on damage to building structures following our return to Tokyo. Mr. Hajime Tsuchida of the Port and Harbour Research Institute made some of the strong motion records available to the team and provided information on damage in the port of Ishinomaki.

In addition to those already mentioned, acknowledgments are due Mr. Keiichi Ohtani of the National Research Center for Disaster Prevention, Science, and Technology Agency; Messrs. Haruo Yoshikoshi and Yasou Watanabe of the Sendai Construction Office, Ministry of Construction; Mr. Shigeyoshi Shima, Tohoku Regional Construction Bureau, Ministry of Construction, Messrs. Kunimatsu Hoshihata, Chutarō Chiba and Tsuyoshi Soto of the Kitakami-Karyu Construction Office, Ministry of Construction; Mr. Kazuhiko Kawashima of PWRI; Messrs. Nagahisa Ikuta, Masaki Takahashi and Osamu Yotsuyanagi of the National Land Agency; Messrs. Hidenao Miyamoto and Toshio Shono of Tohoku Petroleum Co., Ltd., Mr. Chunchiro Kiowa of the City of Sendai; Messrs. Masashige Sasaki, Tokashi Shibuya, Yokio Matsuzaki and Akira Tokano of Miyagi Prefecture; and Professors Akio Takagi, Ishii, Hisao Nakagawa, Akenori Shibata and Toshio Shiga of Tohoku University; Messrs. Takashi Hirai, Yoichi Fujii, and Noboru Inouchi of the Geographical Survey Institute in Tokyo.

On the U.S. side, Drs. Edward O. Pfrang and H. S. Lew of NBS, chairman and secretary, respectively, of the U.S. Panel of UJNR, made the initial arrangements which were necessary to facilitate the visit of the U.S. structural engineers to Miyagi Prefecture. Mr. Yanev's visit was supported, in part, by the Earthquake Engineering Research Institute. Mr. Louis Cattaneo of the National Bureau of Standards assisted in assembling the material for this report. Mr. Justin L. Bloom, Counselor for Scientific and Technological Affairs of the U.S. Embassy and his assistant, Mr. Bruce Carter assisted Mr. Fowler in his visit.

2. SOCIAL EFFECTS AND GOVERNMENT RESPONSE*

2.1 DAMAGE

There are about 6,500 business and manufacturing firms and about 452,000 households (homes and apartments) in Miyagi Prefecture. In Miyagi Prefecture, 803 dwellings were destroyed (309 in Sendai). Major causes of the destruction were landslides, inadequate foundations, and inadequate lateral bracing. A number of 2- to 4-story apartment buildings were rendered uninhabitable when their first-floors, housing shops or parking space, collapsed.

According to data compiled by the National Land Agency, the earthquake caused damage amounting to 166 billion yen (\$830 million). A detailed outline of the various types of damage and the economic loss that resulted is presented at the end of this chapter. In some cases the amounts listed represent the cost of replacing a building or facility with a modern structure even though the damage caused by the earthquake could be repaired at a lower cost. Almost half of the total damage estimate represents the cost of repairing or replacing factories, stores, and other business establishments as shown in Table 2.1.

Most buildings in Japan have tile roofs. Literally thousands were damaged, this was the most apparent type of damage in the area. (Tile falling from roofs caused a number of injuries.) Item 9 of the damage indicates that 20,634 structures were flooded. Sendai City and Miyagi Prefecture officials reported that four homes were flooded as a direct result of the earthquake. Because of the extensive roof damage, and because the area received heavy rains after June 12, it may be that secondary water damage is reflected in the table.

In considering the damage, one must understand the topography and construction siting areas in and near Sendai. Sendai has three distinct areas: the old (original) city, which is centrally situated on solid level ground, a new section on the eastern side, toward the coast, much of which is constructed on soft, flat ground (some of which includes fill areas); and an area of hills to the north and west, where people have constructed homes and buildings on terraces. Damage and losses were much greater in the soft and hill areas than in the old section.

In the hill areas, unstable fill surfaces in combination with saturated soil caused many landslides. Cracks, mostly associated with the landslides, formed in the terraced ground where houses and apartment buildings were built. According to officials, a total of 337 landslides occurred throughout the prefecture.

Liquefaction in conjunction with inadequate foundations contributed to heavy damage in the flat (soft) area. Reports of dike and levee subsidence were verified in many areas along streams. At Nokahura, which is near Sendai, a dike that was originally 7 to 8 m high settled 1.5 m because of liquefaction.

Reinforced concrete buildings, bridge piers, and bridge abutments settled and sustained damage in many areas due to liquefaction and inadequate footings. Soft soil layers under reinforced concrete structures contributed to much of the damage. It is interesting to note that damage to buildings from north-south shaking motion was often noticeably more severe and extensive than damage from east-west movement. Steel-frame buildings by and large survived the earthquake better than reinforced concrete structures. Some lost facades and windows, and only one collapsed. Older buildings constructed of wood frames were damaged because of inadequate lateral bracing.

A major oil refinery in the port area of Sendai, containing 98 storage tanks of varying sizes, suffered damage when three large tanks containing fuel oil sprang leaks. Several million gallons of oil flooded the refinery area, and some reached the waterway serving the port.

The major cause of deaths and injuries from the earthquake was collapsing or falling walls made of stone or cinderblock. These structures serve as fences, privacy walls, and noise barriers. There is a National Code that requires that walls of this kind that are over

* Prepared by Hugh H. Fowler, Emergency Management Agency, Bothell, Washington.

Table 2.1 Outline of Preliminary Damage from June 12, 1978, Miyagi-ken-oki Earthquake

	<u>Quantity</u>	<u>Value (million \$)</u>
1. Dead	27	--
2. Missing	0	--
3. Injured	1,052	--
4. Households suffering damage	3,477	--
5. Individuals suffering damage	13,768	--
6. Buildings wholly destroyed or burned or washed away	803	--
7. Partially destroyed buildings	5,227	108.7
8. Partially damaged buildings	58,927	--
9. Flooded building	20,634	31.0
Subtotal		139.0
10. Hospitals	119	1.7
11. Clinics	194	0.2
12. Medical equipment	735	1.0
13. Water Works	--	4.8
14. Sanitation facilities	29	5.3
15. Other sanitation facilities	33	7.4
Subtotal		20.4
16. Factories and stores	55,078	455.0
17. Other business establishments		
Subtotal		455.0
18. Paddy fields (ha)	5.5	0.3
19. Fields or farms (ha)	--	--
20. Agricultural facilities	535	24.1
Subtotal		24.5
21. Farm produce (ha)	541.1	1.1
22. Joint-use facilities	424	5.8
Subtotal		6.9
23. Livestock	2,100	--
24. Livestock facilities	35	0.6
25. Livestock products	3	--
Subtotal		0.6
26. Sericultural (silkworm) facilities	12	--
27. Fishing boats	17	--
28. Fishing port facilities	109	13.5
29. Fishery and aquaculture facilities	341	5.0
30. Fishery products	--	0.2
31. Fishing equipment	64	--
Subtotal		18.9
32. Forest land, roads	56	1.6
33. Forestry facilities	38	0.9
34. Forestry products	6	0.1
Subtotal		2.6
35. Primary schools	367	7.0
36. Middle schools	170	2.1
37. High schools	102	7.0
38. Other schools	323	14.7
39. Cultural assets	22	1.2
Subtotal		33.2
40. Roads (sites of damage)	720	16.8
41. Bridges	65	32.1
42. Rivers (sites of damage)	115	6.6
43. Shores	5	1.1
44. Erosion control facilities	12	1.7
45. Ports and harbors	85	7.6
Subtotal		66.0
46. Railways	--	34.8
47. Electrical facilities	--	13.7
48. Communications facilities (sites of damage)	2,660	2.3

	<u>Quantity</u>	<u>Value</u> <u>(million \$)</u>
49. Social welfare facilities	166	3.0
50. Urban facilities	76	4.1
51. Gas facilities	53	2.0
52. Other facilities	231	3.1
Subtotal		62.8
 Total loss		 830.0
 Number of people evacuated by order or recommendation	 26,017	
 Number of communities where headquarters for disaster countermeasures were set up	 56	

1-1/2 m high must be reinforced in both directions with steel bars. (The bars must be at least 9 mm in diameter and must consist of an 80 cm grid across and down the wall.) Some of the walls that fell contained inadequate reinforcing and were more of a danger than those with none: those with no reinforcement tended to crumble, while those with inadequate reinforcing toppled on people who were nearby or who held onto them for stability as the earthquake occurred.

2.1.1 Public Facilities, Services, and Lifelines

Effects of the earthquake on so-called critical facilities, on public services, and on other vital activities were varied. In some cases, functioning was interrupted only temporarily, in other cases, the impact on segments of the population lasted for several weeks.

2.1.2 Law Enforcement and Emergency Services

Only slight damage was sustained by police facilities. The police communication system played a vital role in maintaining order and dispersing factual information immediately after the earthquake. Fire service facilities, also, received little damage, and units had no difficulty coping with the few (10) fires that started.

Of the 41 hospitals in the Prefecture (27 in Sendai), several sustained varying amounts of damage. The natural gas and electricity outage interfered with medical services. However, there were no reported problems with overloading because of the influx of injured to the city for treatment.

2.1.3 Transportation

The National Railway stopped all train service in the area immediately after the earthquake to insure against accidents and to assess damage to the system. Service was restored quite soon after repairs were made, and the safety of the line and its control systems was ascertained. Public bus service in Sendai was hampered in the hours immediately following the earthquake because of traffic light failure. Air service between Sendai and other points was quickly restored after airport officials assessed damage and found that safe service could commence.

2.1.4 Utilities

Damage to the natural gas distribution system in Miyagi Prefecture was a major recovery problem. Gas distribution systems in six cities were severely affected. About 60% of the 200,000 households in Sendai are dependent on gas for heating and cooking. As of June 28, 1978, 22,000 of those households as well as 10,419 households in other cities of the prefecture were still without gas.

Electrical service to 419,100 homes in the prefecture was interrupted. For the most part, service was restored within a day or two. Few distribution line poles were toppled. Two electrical generating plants serving Sendai were out of operation. One of those plants, located near the oil refinery at the port, depended upon fuel from the one refinery that was rendered inoperative. The other, located in north Sendai, was rendered inoperative when the city's storage plant for low-pressure gas caught fire and service had to be terminated. Electrical power from other areas and facilities was diverted and at the time of the reconnaissance was meeting the needs of Sendai, although several factories in the prefecture were still without power.

Within the prefecture, there are about 50 separate water and sewage conveyance systems, most of which are publicly owned. Prefecture officials estimated the damage to these systems, all of which had been restored by June 25, 1978, at about \$30,000,000. Several lift station pumps had to be replaced. Damage to sewer lines in Sendai was minimal, however, until electricity had been restored, the system was partially inoperative. Several nuclear electrical generating plants are located near Miyagi Prefecture. It is interesting to note that none experienced any significant earthquake-related problems or damage.

2.1.5 Communications

All telephone service in Sendai and in the surrounding areas was interrupted from 5:14 p.m. until 8:00 p.m. on June 12, 1978. By 8:00 p.m., 50% of the service in the Sendai area and 75% of the service in areas north of Tokyo had been restored. The disruption extended as far south as Tokyo.

With the loss of electricity, all television and radio stations were unable to broadcast. Several came back on the air soon afterwards by using emergency generators and performed an important service by broadcasting factual information provided by the police and local government officials. However, because most of the population was without electrical service, only those people with battery-operated transistor radios could receive emergency information. (No formal emergency broadcast system exists in Japan.)

2.2 RESPONSE

Immediately after the earthquake, government officials in Tokyo (national), in Sendai (prefecture and city), and in other communities met to take emergency-response action and to plan recovery measures. Sendai established a Disaster Countermeasures Headquarters headed by the mayor. Included in this group were representatives of the National Railway; water, gas, and electric utilities; the police and fire departments; the Red Cross; and others. This headquarters remained operational for 24 hours a day immediately after the earthquake. It was still in operation of June 27, 1978. Actual response activities are the City of Sendai's responsibility. If an emergency is beyond the means of their resources, City officials may request additional services or financial help from the prefecture or national government.

With regard to food and supplies and distribution of emergency rations, the Governor of the Prefecture activated a Headquarters for Self-Sufficiency for the purpose of monitoring food supplies and prices as well as to insure the availability of other items necessary for the populace to survive and recover. Among the tasks the Headquarters performed were:

- Checking on regional and central wholesale markets
- Checking on bread and dairy products
- Checking department and food stores
- Arranging for additional propane bottles and burners
- Monitoring the supply of electric cells (batteries) for flashlights
- Requesting cooperation from the sales industry to maintain stable prices (prices of some critical items actually were lowered during the emergency period)
- Receiving and considering consumer complaints
- Providing propane burners and fuel to handicapped centers
- Providing coordination with producers and suppliers of lumber, glass, concrete, and other building supplies to insure that adequate stocks were available where needed
- Coordinating with National Government officials in Tokyo when necessary.

The headquarters used the media to the fullest extent possible to broadcast factual information concerning supplies and prices. Close daily contact was maintained with 30 designated stores in the area to monitor events.

The police force played a key role in maintaining order and providing information to the populace. Because the lack of electric power limited the effectiveness of the mass media, police used loudspeakers on vehicles. By 8:30 p.m. on June 12, more than 7,000 people had gathered at the Sendai train station (all trains had stopped after the earthquake). The police moved in portable generators, set up lights, and used loudspeakers to provide infor-

mation. By keeping them informed about the likelihood of tsunami or another earthquake and about the damage situation, authorities were able to calm the public and avert panic. By 9:30 p.m., all but 600 of the crowd had dispersed.

A traffic control center was set up immediately after the earthquake to handle the severe traffic problem. Crowds of people and vehicles had gathered at crossings. To deal with this the following measures were taken:

- ° All available police were ordered to duty
- ° The traffic control center monitored critical areas and dispatched police to handle problems
- ° Loudspeakers were used effectively to inform the public.

The damage caused by the earthquake had been judged not great enough for the Prime Minister to issue a National State of Emergency declaration for the Miyagi Prefecture. Article 105 of the Disaster Countermeasures Basic Law provides the basis for issuance of such a declaration. Officials of the Ministry of Construction have visited Miyagi Prefecture to assess the damage caused by the earthquake. On the basis of their assessment, the National Government will determine the amount of national funds to be provided (usually two-thirds of the cost, with the remaining third to be borne by the prefecture).

Japan has a Disaster Relief Act, which is administered by the Ministry of Health and Welfare. Under this authority, which does not require a declaration by the Prime Minister of a National State of Emergency in order to act, relief was approved for two cities and four towns. Each municipality (or prefecture) submits a request, accompanied by data, photographs, and loss statistics to the National Government. Included as benefits under the Act are low interest loans (5.05%) to replace buildings of wood construction. The period of repayment can be extended to 25 years. Homeowners with existing loans on their property are not eligible for much assistance under the Disaster Relief Act other than a low-interest loan. This means that they would need to carry two loan payments, City of Sendai and Miyagi Prefecture officials are trying to get National funding to cover the initial load balance.

The prefecture disaster plan provides that local government heads can request military support and assistance (from the Self-Defense Force). Between June 12 and June 19, such help was requested by the provided to six cities and seven towns. A total of 2,117 military personnel were involved in supplying water to people in areas where normal systems were not operative. They were also instrumental in saving three lives.

Two factors influenced the need for evacuation: the danger of a Tsunami and the unsafe conditions caused by the earthquake damage.

A Tsunami warning was issued at 5:21 p.m. on June 12. The actual order to evacuate must be given by a Mayor or head of government. The Sendai Mayor did not order an evacuation but did issue a warning. Local officials in other coastal communities did issue evacuation orders, and more than 20,000 people moved inland. The "all clear" was received at 8:15 p.m., and those who had left their homes were permitted to return.

Evacuation was necessary to protect people whose homes had been destroyed or judged unsafe for habitation. Approximately 70 families were ordered from their homes in the hill areas of Sendai because of continuing danger of landslides.

Most displaced, evacuated individuals and families stayed with relatives and friends. However, the city and prefecture response plans provide for the use of schools, hospitals, and other public buildings as shelters. Under extreme conditions, the National Defense Force can provide tents or other types of shelter for transient population.

Little search-and-rescue activity was associated with the earthquake. Life-saving measures were performed as necessary by fire and police forces working in the Fire Defense Headquarters, established in affected municipalities immediately after the quake. Two apartment buildings were involved when their first floors collapsed, and evacuation of the occupants of other floors required the assistance of fire departments. The National Self-Defense

Force assisted in locating the body of a missing person. Two other bodies were recovered by neighborhood groups.

The City of Sendai has five rescue teams on alert at all times. When the earthquake occurred and electrical power was lost, the traffic signal system (there are more than 400 signals in the city) became inoperative. Major traffic congestion developed at most intersections, and ambulances were able to respond to only 24 of the more than 200 calls for aid. A central emergency facility, where people could obtain medical treatment, was quickly established in Sendai. Hospitals activated an emergency medical information center, which consisted of computerized data on doctors, hospital bed space, ambulances, etc.

On June 25, only 705 people (in three cities and nine towns) remained in shelters. Sites used for shelters included school gymnasiums, citizens halls, and other public facilities. Emergency rations were distributed by volunteer agencies. The Japanese Red Cross was not asked to participate in the emergency-response or recovery phases of this disaster.

Because both gas and electricity were lacking in many homes, people bought food that did not require cooking. Stores received additional quantities of precooked foods from areas not affected by the earthquake. Fortunately, most grocery stores and markets in the area remained intact, and there was ready access for shopping. Food prices remained stable despite the heavy demand for particular types of food. Because most homes depend upon gas for cooking and heating, the Sendai Gas Company (public) distributed portable gas heaters for purchase at less than cost.

More than 300 homes in Sendai were destroyed. Under certain conditions, the local and prefectural governments may construct prefabricated dwellings for those who lose their homes.

Approximately 70 such dwellings were under construction in Sendai to provide shelter to those who did not have other means.

Neither the City of Sendai nor Miyagi Prefecture attempted to establish or maintain a locator service for missing persons. As soon as the radio and television stations resumed service, selected stations set aside an hour each day to broadcast names and messages. The telephone company also liberalized its use of phones to assist victims.

2.3 RECONSTRUCTION

New construction in Japan must conform with the Architectural Law, which contains special requirements to mitigate earthquake damage and is administered by the Ministry of Construction. Builders must submit plans to prefectural or larger municipal governments for review and approval before starting construction. With very few exceptions, buildings destroyed or seriously damaged had been constructed before the law was in effect.

The Sendai City and Miyagi Prefecture government formed a Reconstruction Planning Committee to ensure that building replacement and repair will contribute toward safety. The committee includes representatives of higher education institutions, commercial and business concerns, industry, and the architectural profession. The Sendai Construction Bureau will insure that new construction in the city meets the requirements of the National Building Code.

2.4 INSURANCE

2.4.1 Unemployment Insurance

Although manufacturing firms and business were hard hit by the earthquake, a large majority of those whose jobs were affected were back at work soon after the earthquake. Some manufacturers who were operating on a marginal basis had not reopened at the time of the reconstruction; the workers affected were drawing unemployment insurance.

2.4.2 Earthquake Insurance

There are at least two types of earthquake insurance available in Japan. Both are expensive.

One type of protection, available to a farmers association, covers 100% of the damage up to a maximum of 25,000,000 yen. Lesser amounts of coverage can be obtained.

The other (major) type of earthquake insurance, is a plan that is endorsed and guaranteed by the government. This program was initiated five years ago but has not met with general acceptance. What appear to be major limitations are its high cost and the limitations on coverage. The maximum coverage for goods is 1.5 million yen (\$7,500), the maximum coverage for homes is 2.4 million yen (\$12,000). (The average home in Japan cost 15 to 20 million yen.) Both city and prefecture officials in Sendai stated they felt that there is a need to equalize the program. It was their consensus that the insurance program will become popular if coverage can be increased and rates adjusted. This type of insurance is required of those who request and receive low-interest disaster-relief loans.

2.5 CONCLUSIONS

The 1977 Disaster Countermeasures Act of Japan, administered by the National Land Agency, requires that each level of government have a plan and a competent organization for dealing with disasters. The rapid and effective response by all levels of government (national, prefectural, and municipal) towards alleviating the affects of the earthquake was the result of a unified, integrated program of disaster preparedness and response.

The amount of recovery work accomplished or under way within two weeks after the earthquake occurred was impressive. The speed and efficiency with which a vast amount of work had been performed was most admirable. Officials responsible for directing operations and others working to accomplish the monumental task of recovery exhibited unusual industry and knowledge about the problems they faced and how to solve them. All, without exception, devoted their efforts exclusively to serving the needs of the people and communities that were adversely affected.

3. TECTONIC AND GEOLOGIC SETTING*

3.1 INTRODUCTION

The Miyagi-ken-oki earthquake of June 12, 1978 occurred in the outer zone of seismicity in Japan, along the subduction zone that bounds the east side of northeast Honshu. This was only one of the many damaging earthquakes that Japan experiences because of its active tectonic setting, and the third in 1978. Most of the larger earthquakes are directly associated with the subduction zone along which the margin of the westward drifting lithosphere under the Pacific Ocean is plunging beneath Japan at a long-term rate of about 10 cm per year. The area where damage occurred in the June 12 earthquake lies on the east coast of northeast Honshu about 300 km north of Tokyo, in a region of low, flat alluvial plains, local alluvial terraces, and steep bedrock terrain of largely moderate relief.

This chapter describes the Miyagi-ken-oki earthquake and its setting as background for the more detailed reports on the effects of the earthquake. The tectonic setting of the earthquake is described, together with the reason that a larger earthquake following the June 12 event was (and still is) a serious, although uncertain, possibility. The June earthquake and its pattern of aftershocks are described, and this pattern is used to illustrate the important distinction between epicentral and fault distance in attenuation studies. Finally, the geology of the affected region is summarized, because of its influence on the distribution, character, and severity of earthquake damage.

This chapter is based on the literature (in English) available in Menlo Park, and on information gained from discussions with, and documents and maps provided by, Japanese officials and scientists during the author's visit to Japan as a U.S. Geological Survey representative on the U.S. team in June 1978. The information is necessarily incomplete because only two weeks had been available for study of the earthquake by the Japanese at the time of the visit to Japan by the U.S. team, and time for discussion and observation during the visit was brief. More thorough accounts will undoubtedly result from the Japanese studies.

3.2 TECTONIC SETTING

Japan is located along the leading overthrust margin of Asia against subducting sea floor of the Pacific plate (inset, Figure 3.1). That plate is drifting northwestward toward the nearly stationary Asian continent, as recorded over the past 40 million years by the Hawaiian chain of volcanoes strung out northwest of the eruptive source now beneath Hawaii. The subduction zone beneath northeast Honshu is marked at the surface by the Japan deep-sea trench and associated island arc, one of several extending around the perimeter of the northwest Pacific (Aleutian, Kurile, Northeast Honshu, Izu-Bonin, and Mariana arcs).

The northeast Honshu arc system consists of a concentric sequence of tectonic elements (Figures 3.1 and 3.2): from east to west, (a) the subducting oceanic plate and deep-sea trench, (b) a submerged forearc terrane consisting largely of the inner-trench slope and a broad deep-sea terrace underlain by more than 2 km of Tertiary sediments, (c) the emergent frontal arc, (d) a volcanic chain atop the front of (e) a deformed backarc geosyncline, and (f) a backarc basin. Most of the arc system is underlain by ancient continental basement, which is bounded on the east and west by thinner oceanic crust, on the east by the Pacific plate, and on the west by the crust of the backarc basin, formed during the early Tertiary opening of the sea of Japan.

This pattern of tectonic features concentric with the Japan trench was established about 25 million years ago, when the Mizuho orogeny began in northeast Honshu with block faulting, subsidence, and extensive volcanism west of the Morioka-Shirakawa tectonic line (Figure 3.1). The Miocene faults broke obliquely across the older north-northwesterly trending structure, such as the Tanakura tectonic line (Figure 3.2). The present tectonic regime is a later phase of that orogeny, in which Quaternary compressional deformation marked by northeast-trending reverse faults and overturned folds has supplanted the earlier extensional regime.

* Prepared by Carl Wentworth, U.S. Geological Survey, Menlo Park, California

Explanation of Symbols for Figure 3.1

- Qs Quaternary sediments, consisting of alluvium, terrace deposits and lake beds
- N Neogene sediments and Cenozoic volcanics, including the extensive Early Miocene green tuff, folded younger sediments, and Quaternary volcanics
- pN Pre-Neogene rocks, including Paleogene and Mesozoic rocks, metamorphic rocks, and Cretaceous or older plutonic rocks; exposed rocks as old as Silurian are recognized. Abukuma block largely plutonic rocks; Kitakami block largely late Paleozoic and early Mesozoic metasediments and scattered plutonic masses
- △ Active volcano
- Morioka-Shirakawa tectonic line (MSTL, approximate location) and the boundary in early Miocene rocks between thick, mainly marine, altered tuff (the green tuff) on the west and thin, mainly terrestrial volcanic rocks on the east
- Contact, dashed offshore where location very approximate, dotted along limits of information offshore
- Major fault, including the Itoigawa-Shizuoka tectonic line (ISTL) along the west margin of the Fossa Magna zone of deformation and low topography, the Median tectonic line (MTL) of Southwest Japan, and the Tanakura tectonic line (TTL). Dashed where approximately located; dotted where concealed
- ==== Quaternary fault, longer than 10 km, which offsets or deforms late Pliocene or Quaternary deposits
- ▲▲▲ Arc (inset): A - Aleutian; K Kurile; H - Northeast Honshu; I-B - Izu-Bonin; M - Mariana. Teeth on upper plate

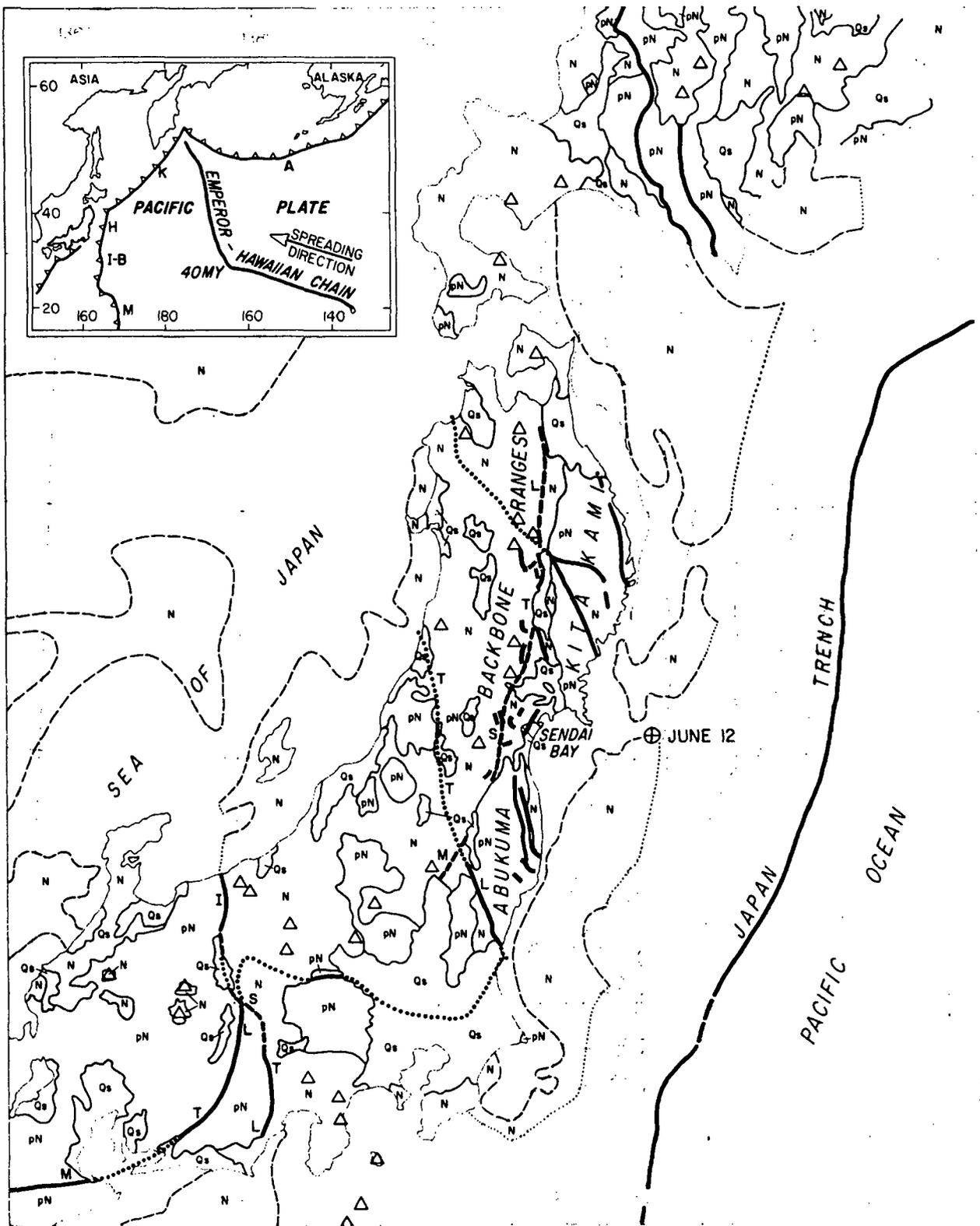


Figure 3.1 Geologic map of northeast Honshu region and plate tectonic setting, compiled from Dickinson (1979), Geological Survey of Japan (1964), Ishiwada and Ogawa (1976), Isomi (1968), Research Group for Quaternary Tectonic Map of Japan (1969), and Yoshida (1975).

Explanation of Symbols for Figure 3.2

Qu	Quaternary volcanic rocks
Qs	Quaternary sediments
N	Neogene sediments and volcanic rocks
Pe	Paleogene sediments
Mz	Mesozoic rocks
Pz	Paleozoic rocks
b	Basement rocks (pre-Silurian)
a	Accretionary wedge - deformed sediment presumably scraped from oceanic plate during subduction
-----	Envelope of seismicity along and above top of subducting slab, from Figure 3.4
∅	Location of hypocenter and apparent dip of focal mechanism for June 12, 1978 earthquake
—————	Approximate extent of June 12 fault rupture in section
6.1	Seismic velocity in km/s

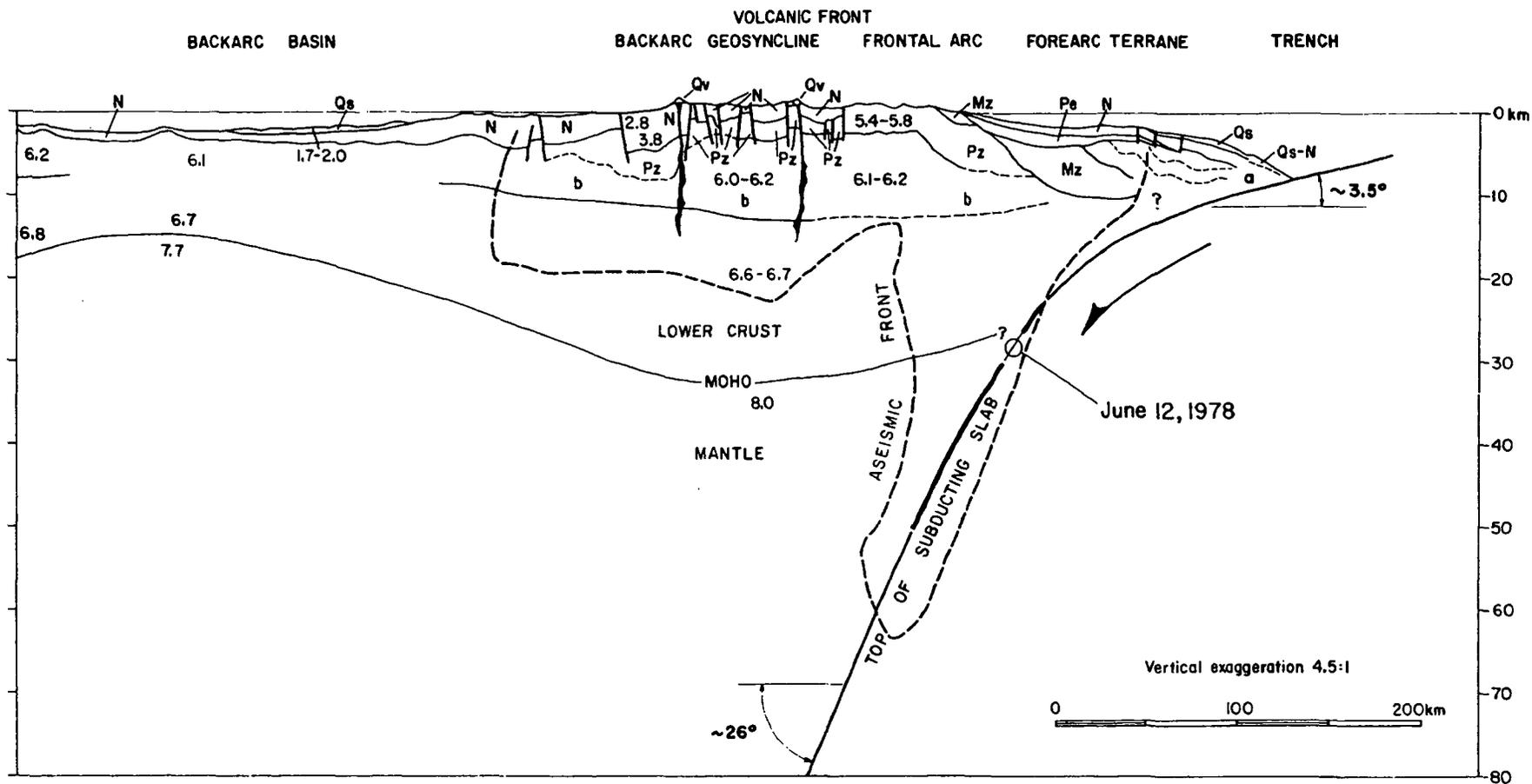


Figure 3.2 Schematic cross sections of Northeast Honshu arc. Drawn along an east-west profile through the Kitakami block, with information spliced from figure 18 of Kitamura and Onuki (1973), figure 1 of Von Huene, Nasu, and others (1978), and figure 6 of Takagi and other (1977). Locations of trench, eastern shoreline, and volcanic front used to register source sections.

The known reverse faults in northeast Honshu are short, scattered, and few relative to the numerous Quaternary faults of varied style in central Honshu and the 800-km-long strike-slip fault along the Median tectonic line in southeast Honshu (Matsuda, 1977). Most of the faults occur along and west of the Morioka-Shirakawa tectonic line and in the Sendai region between the Abukuma and Kitakami structural blocks. Some of these faults have undergone quite recent movement, but apparently none were involved in the June 12 event.

Most of the present relief in northeastern Honshu has formed during this Quaternary compressional phase of the Mizuho orogeny. Beginning 1 to 3 million years ago, the average rate of the vertical movements that accomplished these changes increased tenfold to the order of 1 to 10 mm/yr (Matsuda, 1976). Concurrently, renewed volcanism built the modern volcanoes aligned just west of the frontal arc.

This third and current phase of the Mizuho orogeny, following the initial volcanism and development of the backarc geosyncline and its subsequent breakup and gradual uplift, suggests some change in the subduction regime that drives the system. One possibility is a change in subduction rate. Based on study of the ages and positions of volcanoes in the Emperor-Hawaiian chain, Shaw, Jackson, and Bargar (1979) suggest that a threefold increase in the rate of west-northwestward drift of the Pacific plate relative to the magma source occurred about 1.3 million years ago.

Modern seismicity indicates that subductive underthrusting continues along the northwest Pacific island arcs. The regularity of great thrust earthquakes in space and time that characterizes the Aleutian and Kurile arcs decreases along the northeast Honshu arc, however, and such earthquakes appear to be lacking along the Izu-Bonin and Mariana arcs to the south. The degree to which the convergence rate of the plates is expressed in major thrust earthquakes also seems to decrease southwestward: in the Aleutian arc, probably all the plate convergence is accounted for by faulting associated with major earthquakes, whereas only about one fourth is accounted for at the southwestern end of the Kurile arc and almost none at the southern end of the northeast Honshu arc (Kanamori, 1976, 1978).

Decoupling between the converging plates seems required to permit subduction along the Northwest Honshu arc without the crustal strain that produces major earthquakes. This decoupling may be associated with the anomalously small accretionary wedge found at the trench off northeast Honshu by Von Huene, Nasu, and others (1978). They indicated that the volume of sediment brought to the trench atop subducting oceanic lithosphere in the late Cenozoic has far exceeded that now caught in the accretionary wedge. Most of it must have been subducted, therefore, either to cause, or more likely, to result from, decoupling between the plates. This lack of close coupling is attributed by Kanamori (1976) to active sinking of the subducting slab away from the Asian continent. By this argument, the subducting plate is not only plunging westward beneath Honshu and the Sea of Japan but is bodily sinking, so that the downward bend beneath the forearc terrane is migrating eastward.

The Miyagi-ken-oki earthquake occurred beneath the forearc terrane midway between the ends of the Northeast Honshu arc. Its setting is thus largely independent of the structural nodes at the junctions with adjoining arcs in the Tokyo-Fossa Magna region and south of Hokkaido. As shown in the schematic cross section representing structure across the center of the arc system (Figure 3.2), the subduction zone extends westward beneath the forearc terrane at an initial shallow angle of about $3\text{--}1/2^\circ$. Beneath the forearc basin, where the top of the subducting plate abuts the lower crust of northeast Honshu, the subduction zone gradually steepens until, free of the continental crust at about 30 km, it extends into the mantle at a dip of about 25° .

The full extent of the subduction zone is best shown by the three-dimensional pattern of earthquakes in the region (Figure 3.3). The earthquakes occur at greater and greater depth to the west, defining a Benioff zone that extends westward for more than 1,000 km beneath northeast Honshu and the Sea of Japan at an angle of about 25° , reaching depths greater than 500 km near the coast of Korea.

In greater detail (Figures 3.4 and envelope of seismicity in Figure 3.2), microearthquakes more precisely define the upper part of the subducting plate. The upper boundary of the subducting slab is clearly defined as dipping westward at about 25° beneath northeast Honshu, with a second westward-dipping zone of earthquakes within the slab about 40 km

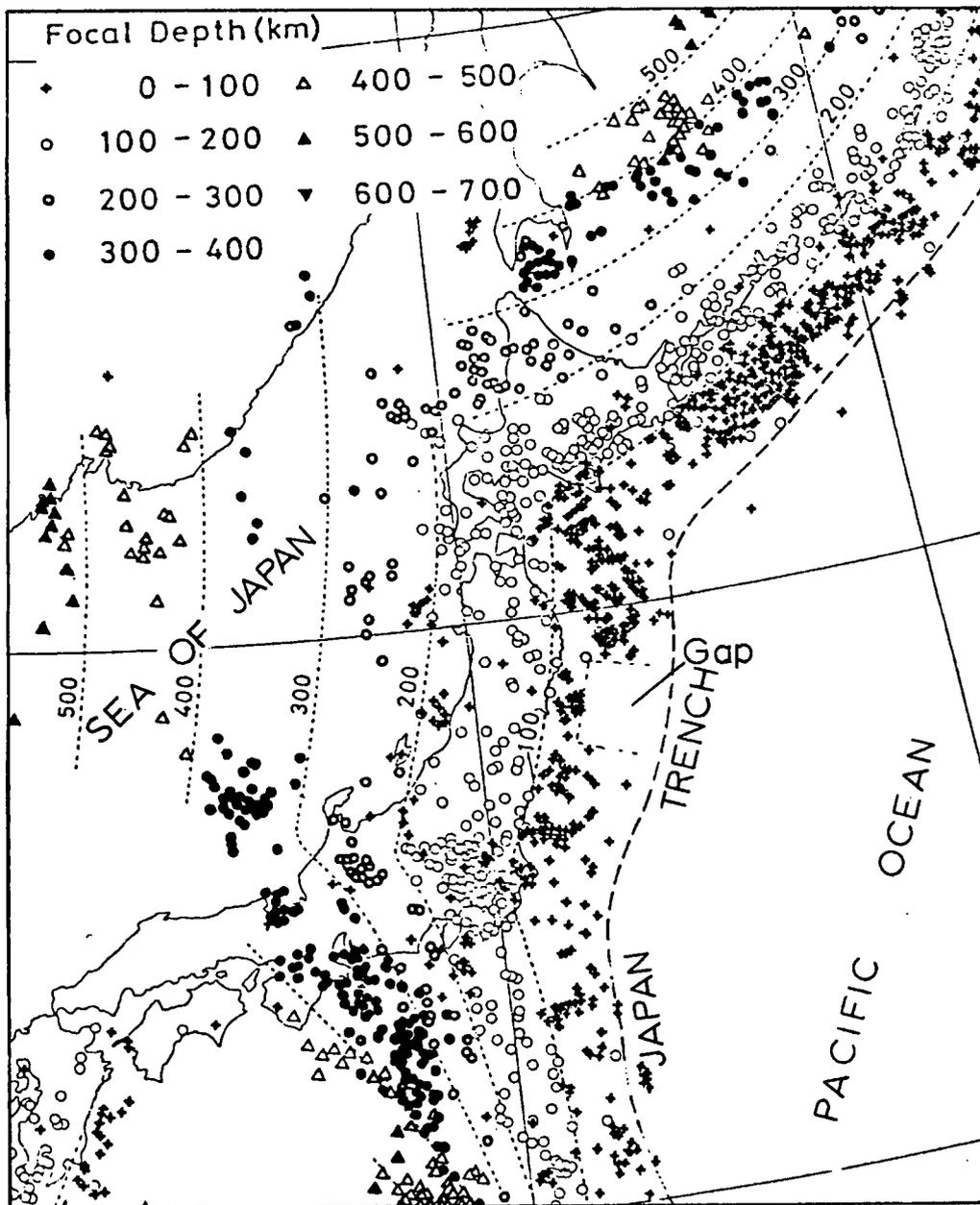


Figure 3.3 Earthquake hypocenters beneath Japan for the period 1964-1974. Epicenter symbols show depth of hypocenter, depth contours in kilometers. From Coordinating Committee on Earthquake Prediction (1978).

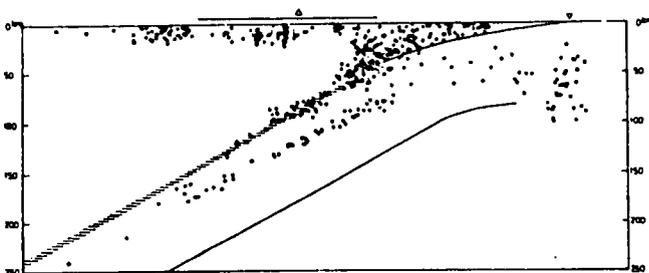


Figure 3.4 Distribution of micro-earthquakes (dots) beneath northeast Honshu in vertical, east-west section in the vicinity of 39-40 degrees north latitude, and subducting oceanic lithosphere. Horizontal line above section represents land, the upright triangle the volcanic front, and the overturned triangle the Japan Trench. From figure 6 of Takagi and others (1977).

beneath the first (Hasegawa and others, 1978; Takagi and others 1977). A zone of high activity is also shown above the subduction zone beneath the forearc terrane. The frontal arc is nearly aseismic, and a shallow zone of earthquakes extends westward from the edge of the frontal arc beneath the backarc geosyncline.

Analysis of the sense of first motions of microearthquakes recorded by the northeast Honshu seismographic network has been made by Hasegawa and others (1978) to determine the style of faulting associated with the earthquakes. These composite focal-mechanism solutions, although varied in detail, indicate that thrust faulting with compression nearly perpendicular to the trench is underway at and above the upper boundary of the subducting slab, as would be expected from the plate motions. In contrast, the band of seismicity within the slab involves extension along its dip direction.

Historic damaging earthquakes along the northeast Honshu arc form three groups evident in a compilation of damaging earthquakes that have occurred in and near Japan over the past one and a third millenia (Japan Meteorological Agency, no date; and Figure 3.5). A modest number of great earthquakes have occurred with epicenters near the trench, largely involving faulting along the gently dipping part of the subduction zone. Closer to shore, more numerous intermediate-size damaging earthquakes have occurred with epicenters in a band along the forearc basin trend. These earthquakes appear to involve faulting along the top of the steeper part of the subduction zone. A scattering of generally smaller damaging earthquakes has occurred with epicenters onshore, along and west of the Morioka-Shirakawa tectonic line. The frontal arc appears to be nearly free of damaging earthquakes, except in the gap between the Abukuma and Kitakami highlands near Sendai.

3.3 SEISMIC GAP AND PRECURSORS

The Miyagi-ken-oki earthquake of June 12 occurred adjacent to an area for which there was some evidence to suggest a forthcoming major earthquake. Gaps of uncertain significance existed in the pattern of both major and smaller earthquakes. The following summary is based on discussions held during the team visit in Japan and on Abe (1977), Coordinating Committee on Earthquake Prediction (1978), Mogi (1968), Kanamori (1976, 1978), and Shimazaki (1978).

The regularity with which great thrust earthquakes have occurred along subduction zones has led to the use of gaps in the pattern of fault rupture areas as a basis for identifying expectable earthquakes. The focal areas of the earthquakes tend to fill the length of the subduction zone with little or no overlap between adjacent events, and gaps in the pattern of the most recent earthquakes tend to be filled in. This regular pattern of repeated earthquakes extends around the northwest Pacific as far as the junction between the Kurile and Northeast Honshu arcs (Figure 3.6). At that junction, interpretation of tsunami data suggests that major thrust faulting and associated earthquakes occurred in 1677, 1763, 1856, and 1968, or about every hundred years.

The latest earthquake in that sequence, the Tokachi-oki earthquake of 1968 (Figures 3.5 and 3.6), is also the southwesternmost in the latest round of great earthquakes along the Kurile arc. East of the Kitakami block (or Sanriku region), the repeat history of major earthquakes seems less regular. And farther south, between latitude 36° and 38° N east of the Abukuma block, the 1938 Shioya-oki series of five large earthquakes (three thrust, two normal) seems to have been the only major earthquake event in at least the past 800 years. The transition along the Northeast Honshu arc from regular behavior of great thrust earthquakes at the north to almost no major earthquakes at the south complicates the application of seismic gap theory to the region east of Sendai. It is not clear whether or when the on-going subduction involves sufficient straining of the lithosphere to produce major earthquakes.

The last major subduction-zone faulting east of the Kitakami block between latitude 38° and 40°N occurred in 1896-1897, when the focal areas of the 1896 Sanriku and associated large earthquakes extended from within the focal area of the 1968 Tokachi-oki earthquake southward to about 38°. Only three earlier major earthquakes are known from the area--in 869, 1611, and 1677--although the historic record is incomplete. Thus the regular, hundred-year repetition of major earthquakes that characterizes the southwest Kurile arc does not persist south of about 40°. If strain has been accumulating since the Sanriku earthquakes of the

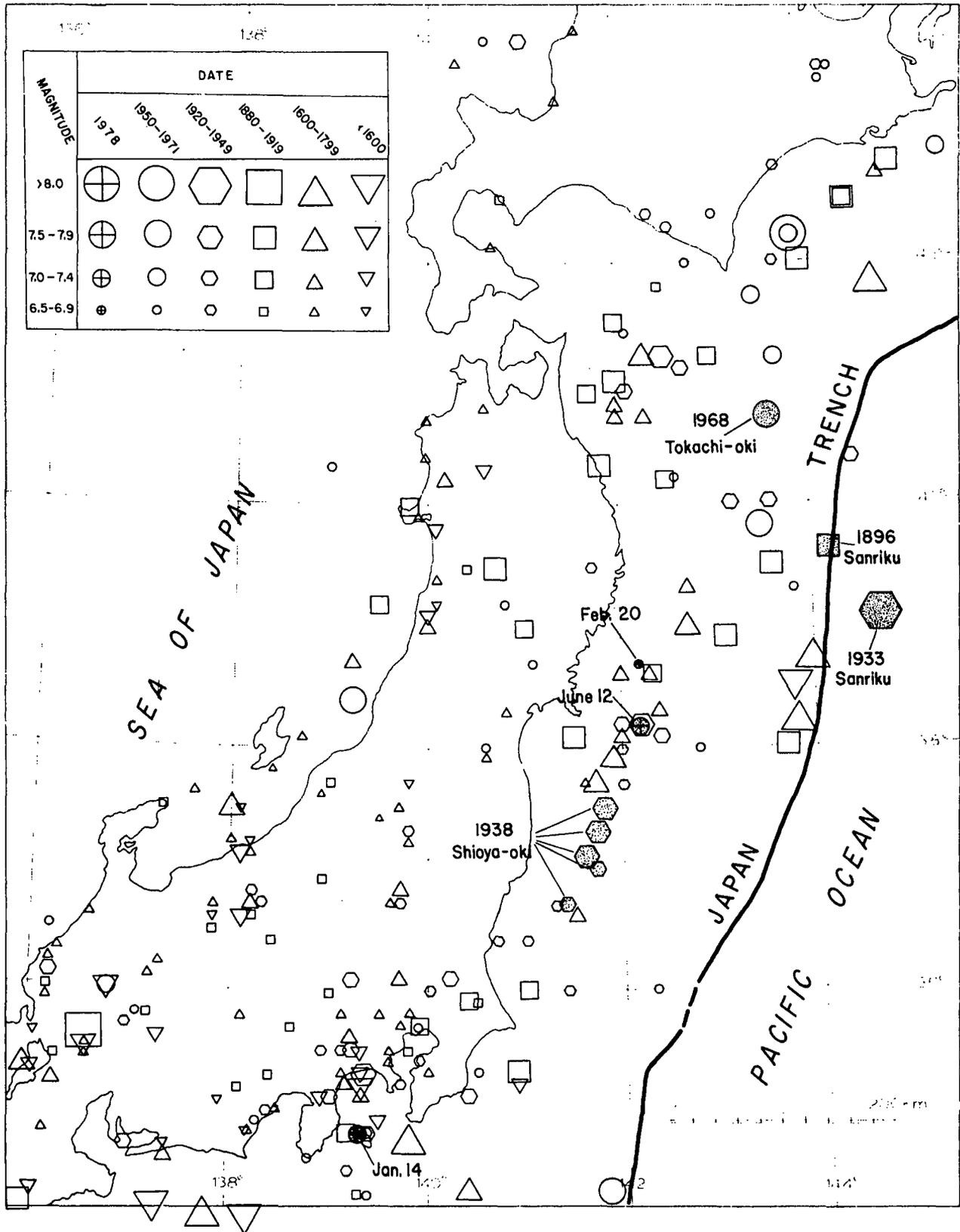


Figure 3.5 Historic damaging earthquakes in the northeast Honshu region. Compiled from 1:2,000,000 map. Disastrous Earthquakes in and near Japan, covering the period 599 to 1975. Older historic data are incomplete. Age classes are based on null points in temporal frequency of earthquakes throughout map area.

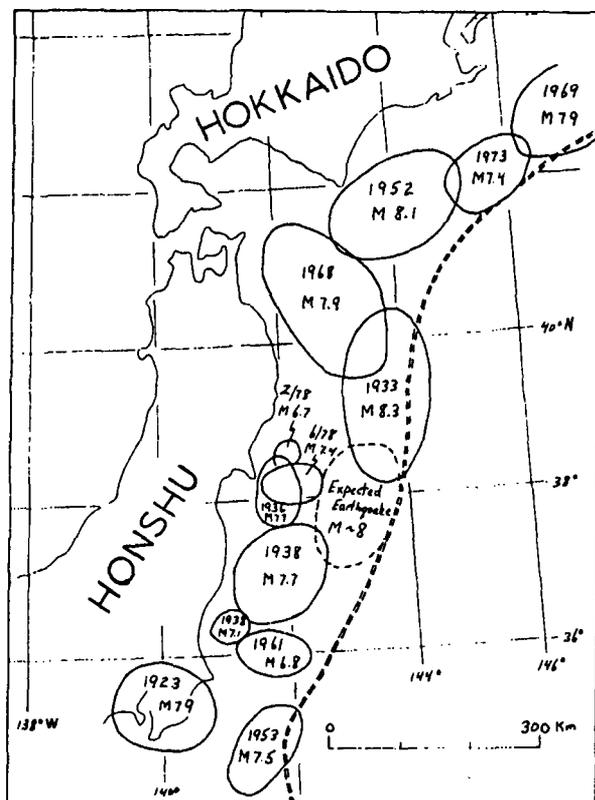


Figure 3.6 Source areas of recent major earthquakes along the subduction zone off Japan, with date and magnitude, and potential great earthquake at latitude 38. From Coordinating Committee on Earthquake Prediction (1978).

late 1890's, it has yet to be relieved by major thrust earthquakes. The role of the 1933 Sanriku earthquake is not clear. Apparently it was not a subduction-zone thrust event, but rather the product of normal faulting within the oceanic plate along a steeply west-dipping plane that extended through the oceanic crust.

Many large earthquakes seem to be preceded, for a period of years, by a lack of smaller earthquakes in the epicentral region. The absence of small earthquakes in the forearc terrane between about 37° and 39° (Figure 3.3) for a period of at least ten years amounts to such a gap in seismicity. This reinforces the uncertain suggestion from the pattern of major earthquakes that the region east of Miyagi may be about due for another major earthquake (Figure 3.6). Because the Miyagi-ken-oki earthquake of June 12 occurred adjacent to, but not within, this gap, a major earthquake may yet occur in the gap.

Particularly because of the seismic gap, other indications of the imminence of a large earthquake have been of interest. Spirit leveling had demonstrated an eastward tilt of the land opposite the gap, but no short-term precursors were recognized prior to the June 12 earthquake. Abundant data from the seismic network of Tohoku University showed no clear change in seismic velocities. Similarly, no indications of imminent earthquakes were evident from the extensometers and tiltmeters that are part of each station in that network.

Comparisons of measurements along two east-west level lines run by the Geographical Survey Institute that end at Sendai and Kamaisi show relative downward tilt to the east of 2 to 5 cm between the center of the island and the east coast in a 7-to-8-year period beginning in 1966. The tilt is greater at Sendai than farther north, an additional 3 cm of decline at Sendai may be related to withdrawal of ground water. Detailed tidal records in the area showed no evident changes with a resolution of a few centimeters within hours after the main shock of June 12, so that little or no coastal uplift accompanied that earthquake.

3.4 MIYAGI-KEN-OKI EARTHQUAKE OF JUNE 12

The magnitude 7.4 Miyagi-ken-oki earthquake occurred on June 12, 1978 at 5:14 PM local time, with its hypocenter at a depth of 30 km at latitude 38.2° N longitude 142.2° E (National Research Center for Disaster Prevention, 1978b). It followed by about 4 months a magnitude 6.7 earthquake that occurred 65 km to the north (latitude 38.7° N, longitude 142.2° E) at a depth of 60 km (National Research Center for Disaster Prevention, 1978a). The February 20 earthquake had a pattern of aftershocks distinct from that of the June 12 earthquake (Figure 3.7) and therefore was not simply a foreshock of the larger earthquake. The main June 12 shock was preceded by one foreshock a few minutes earlier, and was followed by many aftershocks, which were recorded by the seismographic network of Tohoku University (Figure 3.8). Figure 3.9 shows the hypocenter of the main shock and aftershocks through the first 7 hours (A) and aftershocks for the first 10 days following the main shock (B).

A focal-mechanism solution for the main shock, using worldwide data, indicates thrust movement along a preferred plane dipping to the west-northwest at 20° (Figure 3.10, Otsuka and others, 1978). Figure 3.2 shows this solution at the appropriate depth and position relative to the trench and volcanic front. Within the crude accuracy limits of the schematic cross section, the focal plane lies at the top of the subducting oceanic slab.

The aftershock pattern supports and extends this association. The two aftershock patterns of Figure 3.9 are nearly identical, indicating relative stability through time, and suggest mainshock rupture on a west-dipping plane that extends to a depth of about 50 km. The aftershock pattern of Figure 3.9B lies entirely within the equivalent pattern of Figure 3.4, at and above the top of the subducting slab.

The extent of the fault rupture zone can be estimated from the early aftershock pattern (Figure 3.9A). In the dip direction, it extends from at or somewhat above the mainshock hypocenter to a depth of about 50 km (Figure 3.2). This represents a fault width (or down-dip dimension of the focal area) of about 70 km, down which the rupture propagated from the up-dip hypocenter location. The lower end of the fault rupture is here estimated from the depth of the aftershocks, whereas the upper end is estimated from the relative positions of the mainshock epicenter and the eastern end of the aftershock pattern. The strike length of the aftershock pattern, although less well constrained than the east-west direction because of its position offshore of the seismic network, suggests a rupture-zone length of

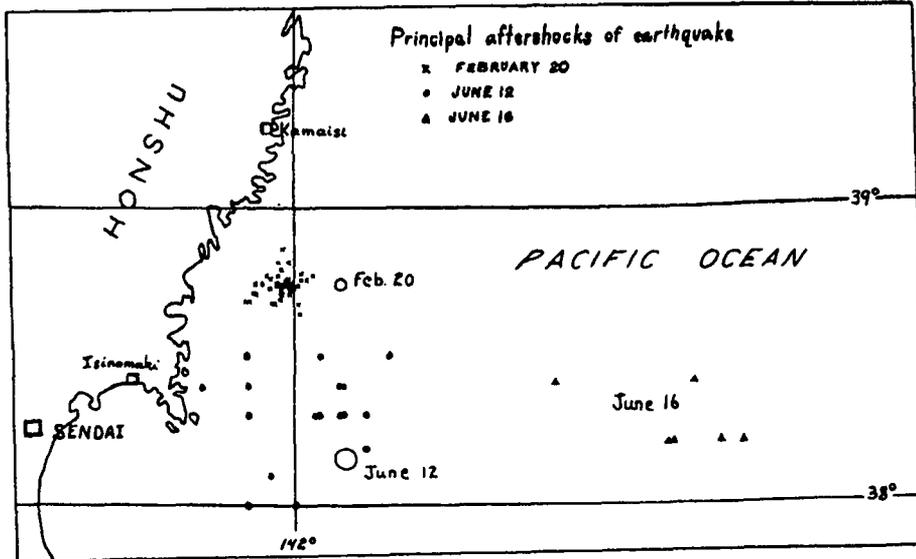
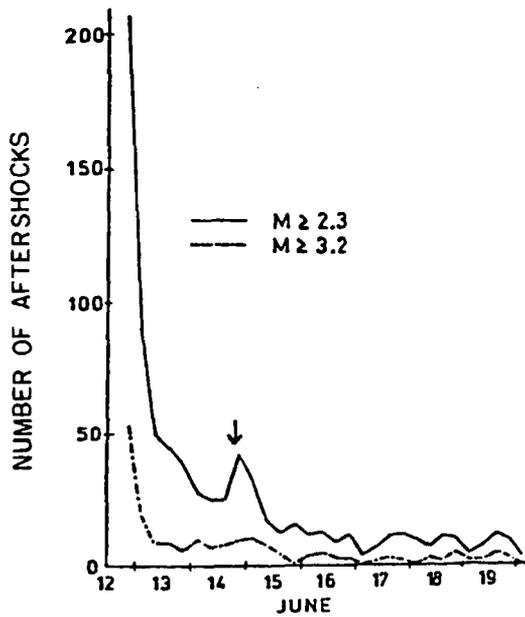


Figure 3.7 Epicenters of the earthquakes of February 20 and June 12, 1978 and principal aftershocks. From Coordinating Committee on Earthquake Prediction (1978).

Figure 3.8 Numbers of aftershocks of the June 12 earthquake through time. Arrow shows time of largest aftershock. From Coordinating Committee on Earthquake Prediction (1978).



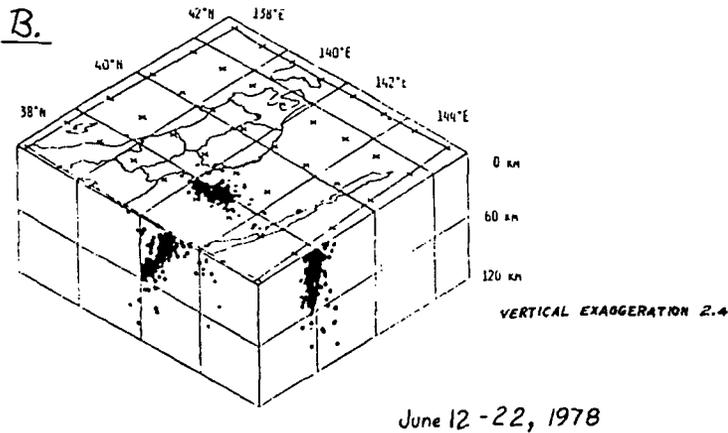
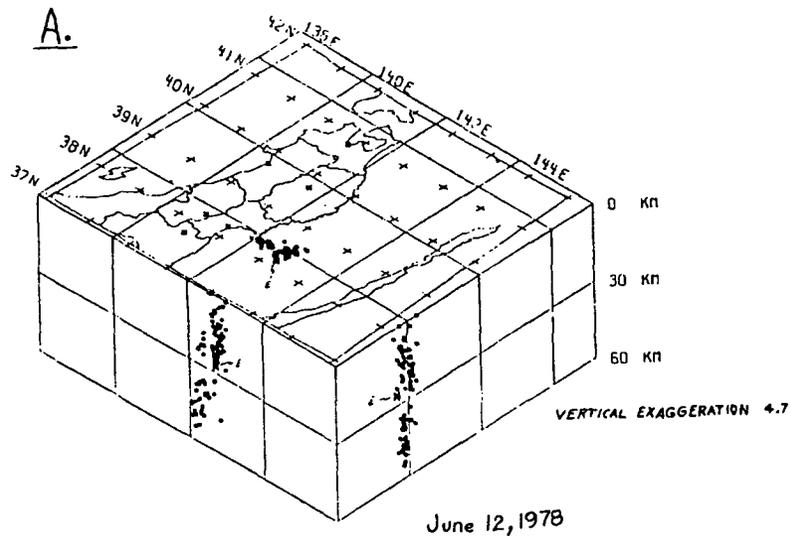


Figure 3.9 Hypocenters of June 12 mainshock and aftershocks through June 22. Block diagram shows projections of hypocenters in map view (epicenters), east-west vertical section, and north-south vertical section. A shows main shock at X (labelled E) and aftershocks through midnight of June 12 to 60 km depth. (From Coordinating Committee on Earthquake Prediction, 1978). B shows aftershocks through June 22 to 120 km depth (from figure provided by Observation Center for Earthquake Prediction, Tohoku University, June, 1978).

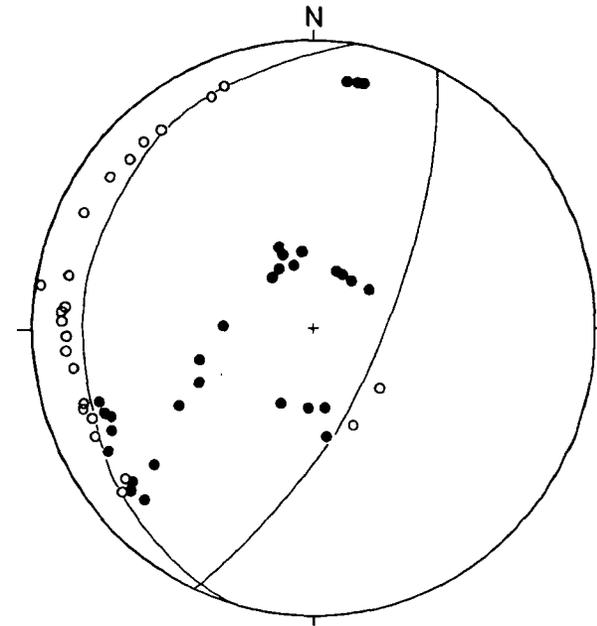


Figure 3.10 Focal mechanism

Figure 3.10 - Focal mechanism diagram for the June 12 main shock, using worldwide data. Filled circles represent compressions. From Otsuka and others (1978).

about 50 km. These dimensions are similar to the focal dimensions reported by Kobayashi and others (1978), a fault width of 80 km and a length of 30 km.

The June 12 earthquake thus occurred along the subduction boundary where it steepens before extending to depth in the mantle. Inasmuch as the focal area of the earthquake lies west of the seismic gap (Figure 3.6), the faulting did not encroach upon the area of unrelieved strain suggested by the gap. The locations of the June 12 earthquake and the earlier earthquake in February raised the possibility that they were precursors of a larger earthquake that would fill the gap. On June 16 several earthquakes as large as magnitude 5.9 did occur in the gap area (Figure 3.7). The aftershock train of the June 12 earthquake decayed rapidly, however, perturbed only by one aftershock somewhat larger than magnitude 6 and an associated increase in activity on June 14 (Figure 3.8).

3.5 LOCATION OF ENERGY SOURCE

The location of the source of seismic energy is an important parameter in studies of the attenuation of seismic shaking. The earthquake epicenter is commonly used as an approximation of this location, largely because epicentral locations are available for most modern earthquakes. Despite the convenience, however, measurement of attenuation distances from the epicenter of an earthquake can be highly misleading, as implied by Page and others (1972) in their discussion of peak acceleration and described by Youd and Perkins (1978) in their discussion of liquefaction.

Strike-slip rupture, for example, can pass close to a site of interest, even where the epicenter of the associated earthquake is far distant. This difference can be accommodated by using the shortest distance to the rupture trace rather than the longer epicentral distance. In the reverse faulting at San Fernando, California in 1971, the epicenter lay far north of the damage area in the San Fernando Valley. The inclined rupture surface extended to the ground surface within the damage area, however, so that distances to the nearby fault could be readily measured.

The fault rupture surface in the Miyagi-ken-oki earthquake of June 12 is less obvious, because the epicenter is offshore and the damage area on land lies in the down-dip direction of the inclined rupture surface. The epicenter of this earthquake is about 115 km east of the city of Sendai. The down-dip extent of the early aftershock pattern, however, lies 60 km west of the mainshock epicenter at a depth of about 50 km beneath the Osika Peninsula (Figure 3.9A). If these early aftershocks delineate the mainshock rupture surface, as is probable, then the faulting reached within about 75 km of Sendai in three dimensions and within 55 km in plan view.

3.6 GEOLOGY OF THE DAMAGE REGION

Most of the damage resulting from the June 12 earthquake occurred within the Miyagi region (shown in Figure 3.11), which consists of a broad central lowland bounded east and west by low mountains. To a considerable extent, the distribution and character of the damage were related to the geology of the region (see, for example, chapters 5 through 9 of this volume). The following discussion is compiled largely from the sources of Figures 3.11, 3.12, and 3.13 and Table 3.1, and discussions during the team visit in Japan, including information provided by H. Nakagawa (written communication, 1978).

The broad central lowland, in which much of the damage occurred, consists of low bedrock hills and extensive alluvial plains. It is bounded east and west by north-trending mountain ranges and on the southeast by Sendai Bay. Bedrock in the region consists of granitic and low-grade metamorphic basement, exposed almost exclusively in the southern Kitakami block and the northern tip of the Abukuma block, and a complex sequence of Miocene and Pliocene volcanic rocks and nonmarine to marine clastic rocks that overlie basement in the gap between the two highlands in the Sendai-Ishinomaki area. West of the Morioka-Shirakawa tectonic line, similar rocks are capped by Quaternary volcanoes. Uplift of the region during Quaternary time placed the Pliocene rocks well above sea level and raised the Abukuma and Kitakami blocks even further. Concurrent oscillation of sea level, as the world's glaciers waxed and waned, produced a sequence of coastal and river terraces that is well represented in the vicinity of Sendai. The alluvial plains of the central lowland represent the youngest deposits in the region, formed during recovery of sea level from the last glacial maximum 18,000 years ago.

Explanation for Figure 3.11

Qa	Quaternary alluvium
Qt	Quaternary terrace deposits
Qv	Quaternary volcanic rocks
Tp	Pliocene sedimentary and volcanic rocks
Tm	Miocene sedimentary and volcanic rocks
pN	pre-Neogene basement rocks: slate, sandstone, and schist
—.....	Rifu-Nagamachi tectonic line; dotted where concealed
---40---	Contour on late Pleistocene erosion surface beneath alluvium; contour interval 20 m, sea-level datum
---s---	Limit of bedrock information

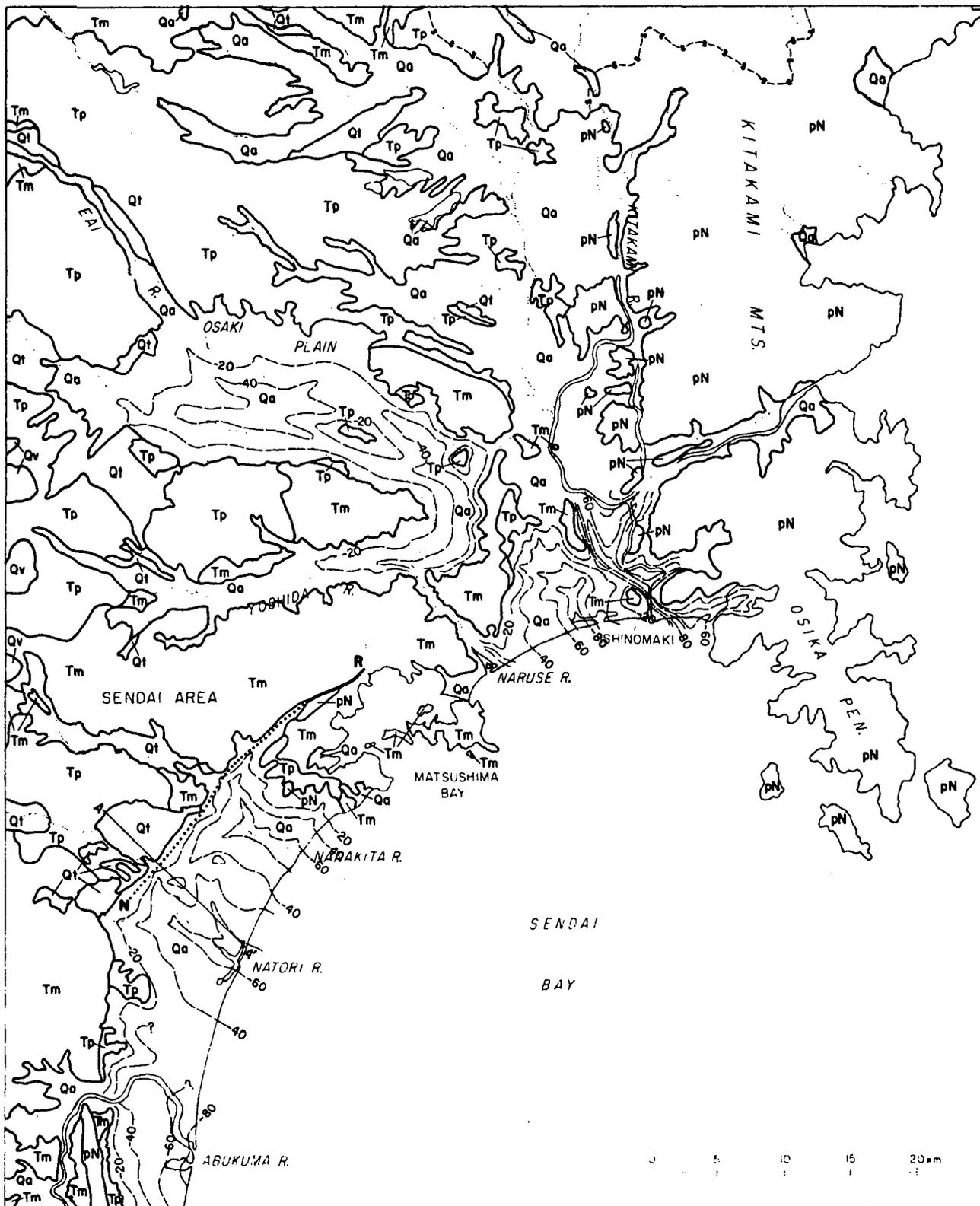


Figure 3.11 Geology of the Miyagi region. See Figure 1.1 for location. Compiled from 1:200,000-scale topographic maps published by the Geological Survey Institute of Japan, Geologic Map of Miyagi Prefecture at 1:200,000, Geological Survey of Japan (1968) and Hase (1967).

Explanation for Figure 3.12

Qp	Quaternary peat; in part overlaps alluvial fan deposits
Qa	Quaternary alluvium; much silt and clay, coarser along rivers
Qaf	Quaternary alluvial fan deposits; sand and gravel
Qt	Quaternary terrace deposits; sand and gravel; numbered 1 to 4 with increasing age
Tp	Pliocene sedimentary and volcanic rocks
Tm	Miocene sedimentary and volcanic rocks
--20---	Contour on late Pleistocene surface buried by Quaternary alluvium; contour interval 10 m, sea-level datum
10---	Selected topographic contours, in meters
. . .	Boundary of area of artificial cut and fill, superimposed on geology; hachures on inside

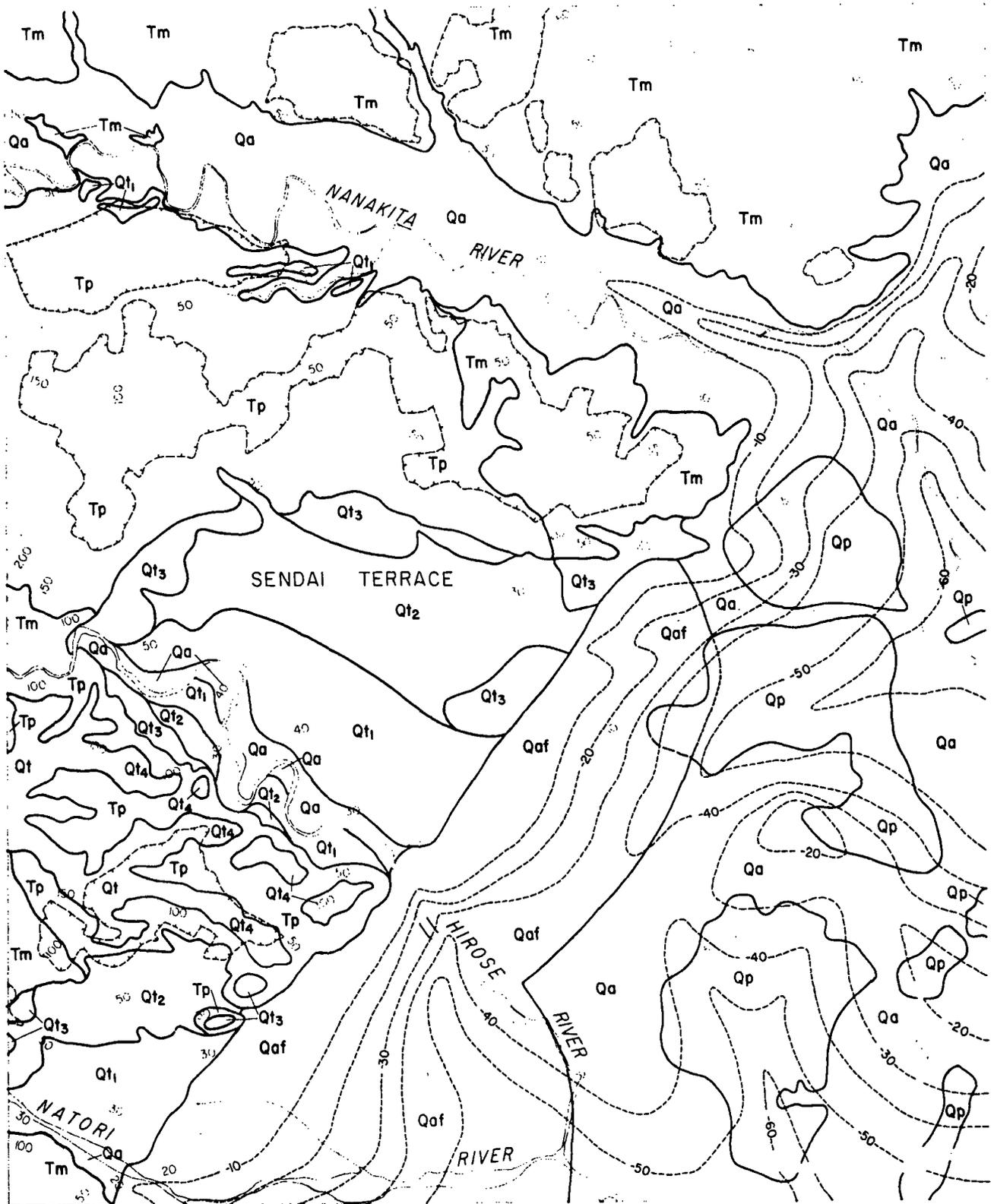


Figure 3.12 Geologic map of the Sendai area, Geology enlarged and generalized from discordant sources: Geologic Map of Miyagi Prefecture at 1:200,000, Geological Survey of Japan (1968), Hase (1967), and Shibata (1962). Base from 1:25,000-scale topographic map. See Figure 3.11 for location.

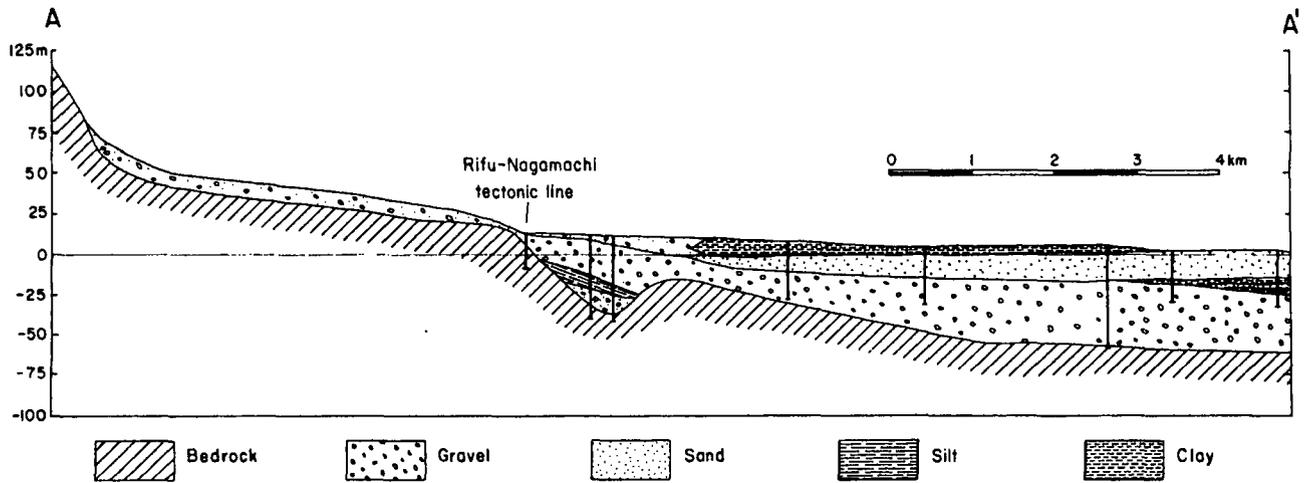


Figure 3.13 Cross section of surficial geology across Sendai terrace and coastal plain. Compiled from Hase (1967), Geological Survey of Japan (1968), and 1:50,000-scale topographic map. See Figure 3.11 for location.

Table 3.1

Stratigraphic Section in the Sendai Region
An approximate, composite section compiled from H. Nakagawa
(written communication, 1978) and Shibata (1962)

Quaternary alluvium: sand, gravel, and clay

--UNCONFORMITY--

Alluvial terrace deposits: sand and gravel

--UNCONFORMITY--

Pliocene Sendai Group

Dainenji Formation - 280 m, shallow marine: sandstone, with siltstone, tuff, and lignite

Mukaiyama Formation - 180 m, nonmarine sandstone, : tuff and conglomerate with a 4- to 15-m tuff (Hirosegawa) near the base

--UNCONFORMITY--

Tatsunokuchi Formation - 300 m, marine: sandstone and conglomerate, siltstone, and tuff

Kameoka Formation - 100 m, nonmarine to brackish: sandstone and siltstone, conglomerate, tuff, and lignite

Mitaka Andesite - 200 m: lava and some agglomerate

--UNCONFORMITY--

Miocene Shirasawa Formation - 200 m, lacustrine: tuff, sandstone, siltstone, and conglomerate, with a 120-m tuff near the middle

--UNCONFORMITY--

Natori Group

Yumoto Tuff - 100 m: dacite tuff, pumice boulders

Hayama Tuff - 50 m: rhyolitic tuff

Tsunaki Formation - 475 m, marine: sandstone, tuff breccia, and siltstone and tuff

Hatate Formation - 200 m, marine: sandstone, siltstone, and tuff

Moniwa Formation - 75 m, marine: sandstone and conglomerate, calcareous

Takadate Formation (or Andesite) - 125 m: andesite, agglomerate, some rhyolite

Tsukinoki Formation - 15 m, nonmarine

--UNCONFORMITY--

Cretaceous and older Basement rocks of the Paleozoic Wariyami Formation (slate and schist), the Triassic Rifu Formation (slate and sandstone), and Cretaceous granitic rocks.

Uplands throughout the region are eroded into intricate, steep-sided ridges, but differences in altitude and relief and in the extent of alluviated lowland distinguish three north-trending topographic belts. (1) On the east, facing the sea, the southern end of the Kitakami block stands 200 to 500 m above sea level, with most slopes inclined between 30 and 50 percent. (2) West of this bulwark, across the south-flowing Kitakami River that marks its western edge, extend the alluvial plains and intervening areas of low, steep-sided hills that form the Kitakami lowland. The heads of the east-trending flood plains on the northwest and the inland edge of the coastal plain facing Sendai Bay on the southwest mark the western limit of this central belt. (3) The lowland is bounded on the west by hills that are nearly everywhere higher than 200 m. Southwest of Sendai, however, a wedge of lower, steep-sided hills extends northward off the end of the Abukuma block. At the northern end of this wedge, the hills bordering the Sendai terrace have valley walls commonly no steeper than 20 to 30 percent and a local relief generally less than 100 m.

The south end of the Kitakami block consists largely of hard, fractured slate and bedded sandstone of Triassic and Jurassic age that very locally contain Cretaceous granitic intrusions. Natural exposures seem nearly absent except along the coast, but the consistently steep slopes of this topographic belt bear only a very thin soil mantle over bedrock where observed in quarries and road cuts.

Most of the bedrock exposed in the region (Table 3.1) accumulated during Neogene time in a structural low in the Sendai region that crosses the frontal arc between the persistently emergent Abukuma and Kitakami blocks. The north-northwest trend of the boundaries of this gap suggests that it was controlled by pre-Mizuho basement structure. Andesitic to rhyolitic volcanism associated with the Mizuho orogeny extended through the Neogene, producing various flows, agglomerates, tuff breccias, and abundant tuffs. Superimposed on the sporadic eruption and erosion of these volcanic rocks was a sequence of three marine transgressions from the southeast and the accumulation of associated terrestrial to marine clastic sequences, separated by intervals of erosion. The limited areal distribution of individual volcanic units, erosion between times of accumulation, facies changes, and onlap relations of the transgressive sequences all combine to produce a complicated arrangement of geologic units.

The Quaternary deposits in the region, on which much of the earthquake damage occurred, consist of extensive young alluvial deposits in the lowlands and a sequence of late Pleistocene terrace deposits. The terrace deposits occur along the upper reaches of the east-flowing rivers near the margin of the western highland and in the Sendai area, where they underlie parts of the city.

The old part of Sendai City was built on the complex Sendai terrace, which consists largely of sand and gravel some 5 to 7 m thick overlying Neogene bedrock (Figure 3.12). These sediments are slightly consolidated, and yield N values of 20 to 60 (Kobayashi and others, 1978). Recent growth of the city led to expansion into the adjacent hills, where higher terrace deposits as well as Neogene bedrock were encountered, and eastward onto the Holocene coastal plain.

The alluvial sediments of the Sendai coastal plain and the other plains of the central lowland bury a late Pleistocene topography that consists of river valleys, flanking terraces, and divides (Figures 3.11 and 3.13). At the coastline, the bottoms of these valleys lie 60 to 90 m below sea level; they extend upstream approximately along the courses of the present surface drainage. From Ishinomaki, a deep, buried gorge extends northwestward for more than 10 km. North of Matsushima Bay, bedrock is 20 to 40 m deep along the Yoshida River for nearly 10 km above its junction with the Naruse River, and farther north, the paleo-Naruse valley beneath the center of the Osaki plain 30 km from the coast is still 40 m below sea level. In contrast, the valleys buried beneath the Sendai plain shallow rather abruptly from 50 to 60 m to less than 10 m below sea level within 6 to 8 km of the coast, near the Rifu-Nagamachi tectonic line.

The late Pleistocene topography was buried by alluvium in the past 18,000 years as the continental ice sheets of the last glaciation melted and sea level rose more than 100 m to its present position. The rise in sea level proceeded about an order of magnitude faster than the average rate of Quaternary uplift in the region, so that the rivers draining the uplands to the west and north found their progress gradually blocked by the rising sea. This caused

their sediment load to be deposited along their lower reaches, resulting in an effective drowning of the late Pleistocene topography that left upland islands and headlands flooded in a sea of alluvium. Along the outer side of the Kitakami block, the intricate drowned coastline misleadingly suggests major tectonic depression of the block.

As sea level rose, gravel and sand began to accumulate within the deep channels, and near the coast, ultimately filled them. Then, toward the middle of the Holocene, a central clay zone that ranges from 5 to 35 m thick was deposited across most of the alluvial terrane. Finally, a sand unit 10 to 20 m thick and an overlying sequence of clay and sand of similar thickness were deposited. This generalized alluvial section varies in detail from place to place in the central lowland. It closely represents the section beneath the Sendai plain, except that the central clay zone is limited to the shoreward part of the plain (Figure 3.13). The Osaki plain tends to lack the shallow sand unit, whereas in the Ishinomaki area the surface section is dominantly sand, giving way to thick clay sections in the eastern embayments.

The uppermost part of the alluvial section consists of an intricate assemblage of sediment types produced as the rivers migrated about on the aggrading plain. Under such circumstances, broad ribbons of channel sand and gravel are left as the rivers change their position from time to time, finer sand and silt are deposited in flanking natural levees in time of flood, and organic silt and clay accumulate in the intervening backmarsh areas. Low ridges of beach sand form along the shore. The sediment is soft and water-saturated, because it is young and the water table is very shallow.

The surface of the alluvial deposits is quite flat, and is still crossed by the several rivers responsible for depositing the sediment. Where not used for housing, much of the alluvial surface is covered with rice paddies. Surface geologic mapping distinguishes the four facies described: active and abandoned river channels, levees, intervening backmarsh peats and silts, and coastal beach sands (H. Nakagawa, oral communication, 1978). N values range from 1 to 10 in the Ishinomaki region, and to 20 on the Sendai plain. Frequent flooding of the rivers has led to the construction of many dikes, some of which were damaged in the June 12th earthquake.

3.7 REFERENCES

- 3.1 Abe, K., 1977, Tectonic implications of the large Shioya-oki earthquakes of 1938: *Tectonophysics*, v. 41, p. 269-289.
- 3.2 Coordinating Committee on Earthquake Prediction, 1978, Unpublished packet of information used by the Japan Coordinating Committee on Earthquake Prediction in its consideration on June 21, 1978 of the off-Miyagi earthquake of June 12, 1978, various pagings.
- 3.3 Dickinson, W. R., 1979, Plate tectonic evolution of north Pacific rim: *Journal of Physics of the Earth*, in press.
- 3.4 Geological Survey of Japan, 1964, Geological map of Japan: Geological Survey of Japan, scale 1:2,000,000.
- 3.5 Hase, K., 1957, Geology of the alluvial plains of Miyagi Prefecture: *Contributions from the Institute of Geology and Paleontology, Tohoku University*, no. 64, p. 1-45 (in Japanese, with abstract and figure captions in English).
- 3.6 Hasegawa, A., Umino, N., and Takagi, A., 1978, Double-planned structure of the deep seismic zone in the northeastern Japan arc: *Tectonophysics*, v. 47, p. 43-58.
- 3.7 Ishiwada, Y., and Ogawa, K., 1976, Petroleum geology of offshore areas around the Japanese islands: *United Nations Economic and Social Commission for Asia and Pacific, Committee for Co-ordination of Joint Prospecting for Mineral Resources in Asian Off-shore Areas, Technical Bulletin v. 10*, p. 23-34.
- 3.8 Isomi, H., 1968, Tectonic map of Japan, II, Geologic provinces: Geological Survey of Japan, 1:1,000,000 Map Series No. 12, sheet 2 of 2.

- 3.9. Japan Meteorological Agency, no date, Disastrous earthquakes in and near Japan: Japan Meteorological Agency scale 1:2,000,000 (publication recent but no date given).
- 3.10. Kanamori, H., 1976, Seismic and aseismic slip along subduction zones and their tectonic implications in Talwani, Manik, and Pitman, W. C. III (eds) Island arcs, deep sea trenches and back-arc basins: American Geophysical Union, Maurice Ewing Series 1, p, 168-174.
- 3.11. _____, 1978, Nature of seismic gaps and foreshocks, in Evernden, J. F., Isacks, B. L., and Plafker, George (convenor and coorganizers) Methodology for identifying seismic gaps and soon-to-break gaps: U.S. Geological Survey Open File Report 78-943, p. 319-334 and 904-906.
- 3.12. Kitamura, N., and Onuki, Y., 1973, Geological and crustal sections of the A-zone, northeast Japan in Japanese National Committee for Upper Mantle Project 1973, The crust and upper mantle of the Japanese area, part II, geology and geochemistry, Geological Survey of Japan, p. 38-60.
- 3.13. Kitamura, Shin, no date, Geologic map of Miyagi Prefecture: Tohoku University, scale 1:200,000. Publication recent but no date given.
- 3.14. Kobayashi, H., and others, 1978, A report on the Miyagi-ken-oki, Japan earthquake of June 12, 1978: National Science Foundation and others, Proceedings of the Second International Conference on Microzonation, v. 1, p. 587-614.
- 3.15. Matsuda, T., 1976, Empirical rules on sense and rate of recent crustal movements: Journal of the Geodetic Society of Japan, v. 22, no. 4., p. 252-263.
- 3.16. _____, 1977, Estimation of future destructive earthquakes from active faults on land in Japan: Journal of Physics of the Earth, v. 25, suppl. p. s251-s260.
- 3.17. Mogi, K., 1968, Some features of recent seismic activity in and near Japan (1): Earthquake Research Institute Bulletin, v. 46, p. 1225-1236.
- 3.18. National Research Center for Disaster Prevention, 1978a, February 20, 1978 Miyagi-ken-oki earthquake: National Research Center for Disaster Prevention, Science and Technology Agency Japan, Prompt Report on Strong-Motion Accelerograms No. 14.
- 3.19. National Research Center for Disaster Prevention, 1978b, June 12, 1978 Miyagi-ken-oki earthquake: National Research Center for Disaster Prevention, Science and Technology Agency [Japan], Prompt Report on Strong-Motion Accelerograms No. 15.
- 3.20. Okutsu, Haruo, 1968, Hydrogeological map of the coastal region of Bay of Sendai: Geological Survey of Japan, map scale 1:100,000.
- 3.21. Otsuka, Michio, Sudo, Ken, Seno, Tetsuo, and Eguchi, Takao, 1978, Study of focal mechanism of the earthquake on the east coast of Miyagi Prefecture, Japan: International Institute of Seismology and Earthquake Engineering, Building Research Institute, and Faculty of Science, Tokyo University, unpublished report, 3 pages, 5 figures.
- 3.22. Page, R. A., Boore, D. M., Joyner, W. B., and Coulter, H. W., 1972, Ground motion values for use in the seismic design of the Trans-Alaska pipeline system: U.S. Geological Survey Circular 672, 23 p.
- 3.23. Research Group for Quaternary Tectonic Map, 1969, Quaternary tectonic map of Japan: Japanese National Research Center for Disaster Prevention, Science and Technology Agency, scale 1:2,000,000, 6 sheets (1 - Vertical displacements estimated with geomorphological method, 2 - Vertical displacements estimated with geological method, 3 - Vertical displacements compiled from the maps Nos. 1 and 2, 4 - Distribution of faults, 5 - Distribution of folds, 6 - Gipfelflur).

- 3.24. _____, 1973, Explanatory text of the Quaternary tectonics map of Japan: Japanese National Research Center for Disaster Prevention, Science and Technology Agency, 167 p.
- 3.25. Shaw, H. R., Jackson, E. D., and Bargar, 1979, Volcanic periodicity along the Hawaiian-Emperor Chain: American Journal of Science, Jackson volume, in press.
- 3.26. Shibata, 1962, Geology of the Sendai and Nanakita-Sambongi areas Miyagi Prefecture, Science Rep. Tohoku University, 2nd Series, v. 34, p. 239-301.
- 3.27. Shimazaki, K., 1978, Correlation between intraplate seismicity and interplate earthquakes in Tohoku, northeast Japan: Seismological Society of America, v. 68, no. 1, p. 181-192.
- 3.28. Takagi, Hasegawa, Akira, and Umino, Norihito, 1977, Seismic activity in the northeast Japan arc: Journal of the Physics of the Earth, v. 25, Supplement p. S95-S104.
- 3.29. Von Huene, R., Nasu, N., and others, 1978, Japan trench transected: Geotimes, April 1978, p. 16-21.
- 3.30. Yoshida, T. (ed.), 1975, An outline of the geology of Japan: Geological Survey of Japan, 61 p.
- 3.31. Youd, T. L., and Perkins, D. M., 1978, Mapping liquefaction-induced ground failure potential: Proceedings of the American Society of Civil Engineers, Journal of the Geotechnical Engineering Division, v. 104, no. GT4, p. 433-446.

4. STRONGMOTION RECORDS AND DATA*

4.1 INTRODUCTION

In Japan, several government agencies are responsible for independent networks of strong-motion instruments located throughout the country. Among the larger of these accelerograph networks are those operated by the following agencies:

Railway Technical Research Institute (RTRI), Japanese National Railways

Strong Earthquake Motion Observation Center, Earthquake Research Institute (ERI),
University of Tokyo

Port and Harbor Research Institute (PHRI), Ministry of Transport

International Institute of Seismology and Earthquake Engineering, Building Research
Institute (BRI), Ministry of Construction

Public Works Research Insititute (PWRI), Ministry of Construction

Other organizations with interest in strong-motion recording include:

National Research Institute of Agricultural Engineering, Ministry of Agriculture and
Forestry

Nippon Telegraph and Telephone Public Corporation

Japan Building Center Foundation (JBC)

The Strong-Motion Earthquake Observation Council was established in 1967 within the National Research Center for Disaster Prevention (NRCDP) of the Science and Technology Agency. Records recovered from particular earthquakes by the various government agencies are made available to the public in the council's "Prompt Report" publication, which describes the records, gives peak accelerations and epicentral distances, and contains copies of some of the more interesting records. These and other earthquake records are published in the council's annual report. The agencies responsible for the accelerograph networks also report on digitization and analysis of the records collected by them that they consider significant.

4.2 THE SMAC ACCELEROGRAPH

The SMAC strong-motion accelerograph in its various versions has been the main Japanese strong-motion recording instrument since its development between 1951 and 1953 by the Japanese Committee for the Standard Strong Motion Accelerograph. In its earliest form (the SMAC-A), it consisted of a set of three mechanical oscillators which, through a series of linkages, scribed analog traces on a waxed-paper record that was driven past the recording pens at 1cm/sec by a hand-wound spring motor. The natural period of the transducer was 0.1 sec (frequency, 10 cps), and critical damping was provided with an air piston mechanism. A sensitivity of 25 gal/mm (i.e., 25 cm/sec² per mm), corresponding to approximately 4cm/g, was arranged for in the mechanical linkage and allowed recording of accelerations of 1g amplitude without the pens moving off-scale. Some of the models developed after the SMAC-A are listed with their important characteristics in the following table.

* Prepared by A. Gerald Brady, U.S. Geological Survey, Menlo Park, California.

	Damping (fraction of critical)	Natural period (sec)	Sensitivity (cm/g)	Recording speed (cm/sec)	Approximate Number
SMAC-A	1.0	0.1	4.0	1.0	33
SMAC-B	1.0	0.1	4.0	1.0	90
SMAC-B2	1.0	0.14	8.0	1.0	240
SMAC-C	1.0	0.1	4.0	1.0	18
SMAC-D	1.0	0.05	1.0	0.5	21
SMAC-E2	0.60	0.05	1.0	0.25	45
SMAC-Q	0.60	0.05	0.5	0.5	11

The last column indicates the distribution of the various models in 1975 obtained from the response to a questionnaire from the author while at the International Seismological Centre in Edinburgh. An additional 400 strong motion instruments were not included in this response and the total in March of 1974 was actually about 850 (Kuribayashi and others, 1977). By March of 1978 the number of SMAC-type instruments installed throughout Japan in structures or at ground level had reached 1200 (Iwaskai and others, 1978). Additional instrumentation, for example electromagnetic recorders, and special downhole systems are not included.

It is important to note from this table that the majority of the instruments of the SMAC type that are operated in Japan at this time have frequency-response characteristics that are different from the most common modern United States instruments that record on 70-mm or 7-in. film. In particular, the SMAC response at frequencies higher than 7 cps (for the SMAC-B2) or 10 cps (for the SMAC-A, -B, and -C) has been designed to be much less than we are used to seeing with United States instruments such as the SMA-1 or RFT-250. A glance at recordings from these earlier SMAC instruments confirms this lack of high-frequency content.

Another feature of the records made by SMAC-type instruments is that the pens draw arc-shaped curves that have constant radius which are obvious in the higher-amplitude motions. Although peak accelerations can be scaled off without requiring significant correction, it is evident that after digitizing a record with high amplitudes correction procedures must be adopted to handle this instrumental behavior before arriving at true time histories.

Recent developments in Japanese instrumentation have included higher natural frequencies (in the SMAC-D, -E2, and -Q instruments), the use of moving-coil electromagnetic transducers (in the ERS accelerograph developed by the Earthquake Resistant Structures Laboratory, Port and Harbor Research Institute), and recording on analog magnetic tape (in the SMAC-M Instrument). The two instruments in the Engineering Building at Tohoku University, which recorded 240 gal (240 cm/sec², or 0.24g) and 980 gal (1g) at ground level and at the 9th floor, respectively, are SMAC-M instruments operated by the Building Research Institute.

4.3 ACCELERATION RECORDS AT GROUND LEVEL

Figure 4.1 shows the northern part of Japan and the locations of the strong-motion accelerograph stations that provided ground level, basement, or free-field records of the June 12, 1978, earthquake. The codes for the stations are indicated (for example, TH020) and their pertinent characteristics have been obtained from National Research Center for Disaster Prevention (1976) and are reproduced in Table 4.1. In addition to the records shown on the map, there exist 61 additional records taken at basement, first-floor, or ground level, mostly in Tokyo or its vicinity. Of these 61 records, the highest peak acceleration is 0.045g at an epicentral distance of 305 km.

The epicenter was provided by the Japan Meteorological Agency (JMA) and published by the National Research Center for Disaster Prevention, (1978). We have chosen to use these epicenter coordinates, namely, 38°09'N, and 142°13'E, in the sections of this report that discuss the epicenter and epicentral distances.

Figure 4.1 also shows the peak accelerations recorded at ground level, or at the basement of first-floor level in structures. The cities of Sendai and Miyako each have more than one recording. Each set of the three numbers shown gives the peak acceleration recorded

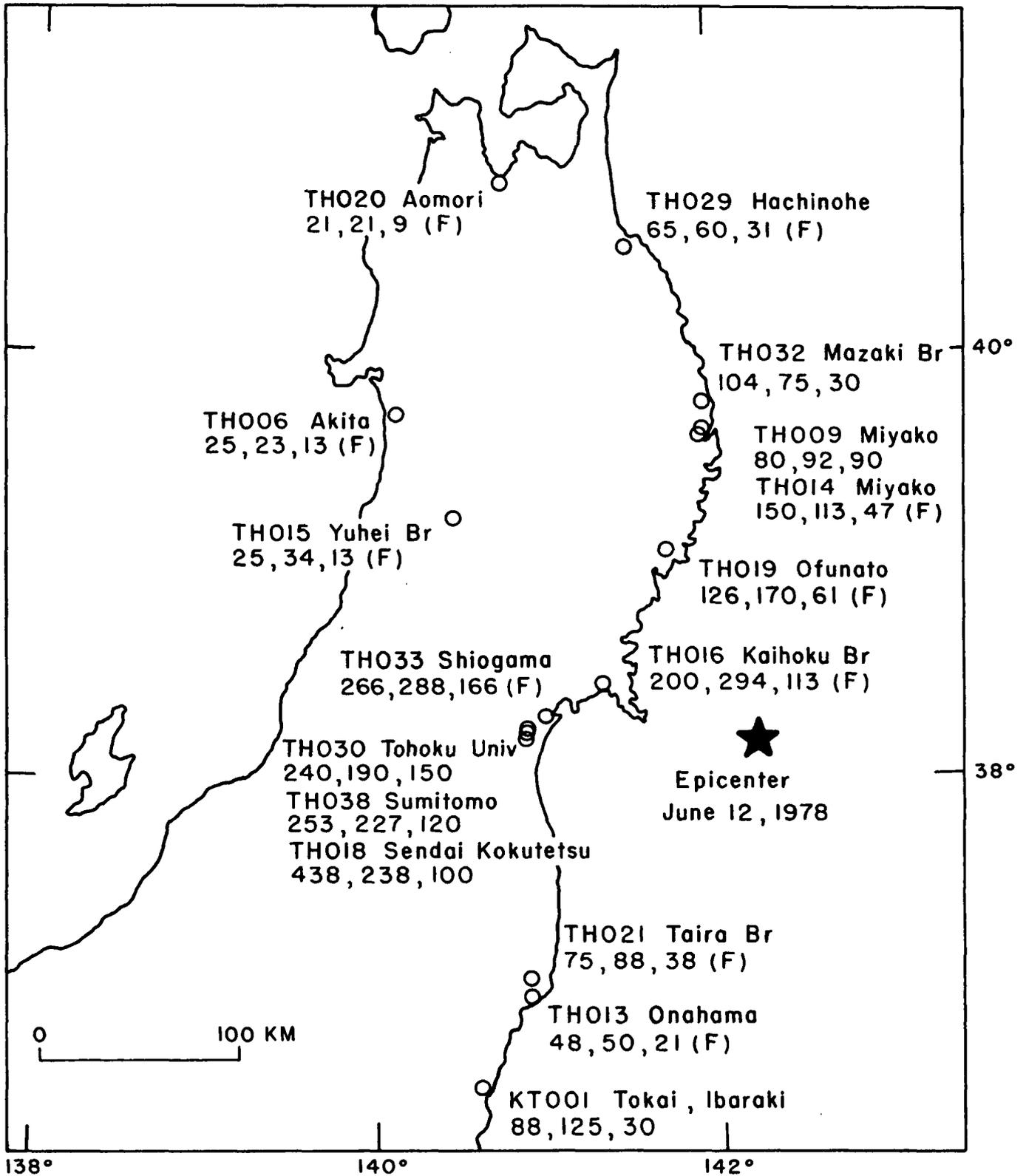


Figure 4.1 Locations of stations providing ground level, basement, or free-field records of the June 12, 1978 earthquake. Peak values in the two horizontal and the vertical directions are given in cm/sec/sec. An (F) following these values indicates an approximate free-field station.

Table 4.1 Ground Level Records

Site No.	Name	Address	Lat. & Long.	Location	Epicentral Distance (km)	Organization	Ground Level Peak Accns. Two horiz, one vert. (gals, cm/sec ²)
TH 006	On the Premises of Akita Harbour Works Office	Taushizakiminato-Nishi 1-chome, Akita City	140°09'E 39°45'N	Ground	247	PHRI	25, 23, 13
TH 009	Schoolhouse of Atage Middle School, Miyako City	Nakasatodanchi, Miyako City	141°59' 39°38'	1F	150	BRI	80, 92, 90
TH 013	On the premises of 2nd Wharf, Omahama Harbour	Tatsumimachi, Iwaki City	140°54' 36°57'	Ground	190	PHRI	48, 50, 21
TH 014	On the Premises of Construction Section Miyako Harbour Works Office	Minatomachi, Miyako City	141°58' 39°38'	Ground	158	FWRI	105, 113, 47
TH 015	Yuhoi Bridge	Jumonji Town, Akita Prefecture	140°28' 39°12'	Crest of pier No. 8 ground	185	FWRI	25, 34, 13
TH 016	Kaiboku Bridge	Inai, Ishinomaki City	141°18' 38°26'	Crest of pier No. 2 ground	80	FWRI	200, 294, 113
TH 018	Sendai Kokutetsu Building	No. 28, Shimizukoji, Sendai City	140°55' 38°15'	B1F, 6F	110	RTRI	438, 238, 100
TH 019	Breakwater of Ofunato Harbour	Akasakicho, Ofunato City	141°44' 39°00'	On the Jetty, ground	100	PHRI	126, 170, 61
TH 020	On the premises of Aomori Harbour Works Office	Honcho 3-chome, Aomori City	140°49' 40°49'	Ground	305	PHRI	21, 21, 9
TH 021	Taira Bridge	Taira-Kanada, Iwaki City	140°54' 37°03'	Crest of Abut, ground	185	FWRI	75, 88, 38
TH 029	On the premises of Hachinohe Factory, Hachinohe Harbour Works Office	Kawaragi, Hachinohe City	413° 403°	Ground	268	PHRI	65, 60, 31
TH 030	Faculty of Engineering Tohoku University	Aramaki, Sendai City		1F	115	BRI	240, 190, 150
TH 032	Manaki Bridge	Taro Town, Iwato Prefecture	141°57'E 39°46'N	Crest of pier No. 1 ground	164	FWRI	104, 75, 30
TH 033	On the premises of Shioyama Harbour Office	Teizandori 1-chome, Shioyama City	141°03' 38°19'	Ground	100	PHRI	266, 288, 166
TH 038	Sumitomo Sendai Building	Chuodori, Sendai City		B2F, 9F, 18F	115	SUMITOMO	253, 227, 120
KT 001	Meteorological Laboratory, Japan Atomic Energy Research Institute	Tokai Village, Iboaraki Prefecture	140°37' 36°28'	1F	242		88, 125, 30

in two perpendicular horizontal directions and in the vertical direction. For most ground-level stations the two horizontal directions referred to are north-south and east-west, in that order, whereas the instruments at the lowest level of a structure are generally aligned in the longitudinal and transverse directions of the structure and acceleration values are reported in that order. The acceleration units used are cm/sec^2 , commonly called a gal. Conversion to g units is simply, if slightly inaccurately, accomplished by dividing by 1,000. An (F) following the acceleration levels indicates that the recording could be considered a free-field recording, although it must be realized that any instrumental housing disturbs the true free-field motion.

The section on seismicity indicates that, although the epicentral distance to Sendai is about 110 km to 115 km, it might be inferred from the aftershock pattern that the main shock rupture plane actually reached a point within about 75 km of Sendai, measured in three dimensions, or within a distance of 55 km, measured in plan. Such a conclusion would play a significant part in studies of the attenuation of peak accelerations for this earthquake, particularly for those stations within latitude 37.5° and 38.5° north that lie approximately due west of both the epicenter and the closest point on the rupture plane. Other stations on the east coast would not be affected because, for each of these, the epicentral distance is approximately equal to the distance to the closest point of the inferred rupture surface.

To illustrate this point in rather elementary fashion, Figure 4.2 shows the peak horizontal accelerations for three groups of ground-level records plotted against epicentral distance. A distinction is made between stations on the coast in a generally northern direction from the epicenter, those generally to the west, and those on the coast to the southwest. A curve labelled "Attenuation to the north" passes through the first group to the north and is a satisfactory approximation for the points of the third group, those to the southwest. Accelerations for the records lying to the west are higher than this curve would indicate, but on moving the points so that their plotted distance is the distance in plan, to the nearest point of the rupture, 60 km to the west of the indicated epicenter, a better fit is possible to an extrapolated attenuation curve. This curve only shows the trend of peak accelerations attenuating with distance - the scatter is evident and its explanation in individual cases will have to wait for detailed study.

4.4 INTENSITIES

Intensities for earthquakes in Japan are prepared by the JMA from information received at their headquarters from observational stations throughout the country. Like their Modified Mercalli equivalents used in the United States, JMA intensities are generally expressed in Roman numerals, but in the tables and figures of this report we have used Arabic numerals for clarity in their presentation.

A brief description of the JMA intensity levels is given in Table 4.2. A comparison of these descriptions with those of the Modified Mercalli Intensity Scale (Wood and Newman, 1931), the standard intensity scale in use in the United States, allows an approximate translation from JMA to MMI values. Considerable engineering judgment regarding the dynamic behavior of the various buildings and other structures in both cultures would be required for such a comparison to be accurate and useful. One possible comparison is shown in the following (Trifunac & Brady, 1975).

JMA	0	1	2	3	4	5	6	7				
MMI	1	2	3	4	5	6	7	8	9	10	11	12

Figure 4.3 is a highly idealized isoseismal map constructed from the plotted JMA intensities at specific locations. The indicated elongation of the isoseismals in the north-south direction is controlled by the locations of the lines as they pass over the land area, where observations are possible. Dashed lines across the Sea of Japan serve only to connect the two portions of the several isoseismals. No attempt is made to estimate the locations in the Pacific Ocean to the east.

The boundary between JMA 4 and 5 is reasonably well constrained to the north and west but less so to the south. The other isoseismals are more arbitrarily chosen. If a circular area were approximated to the JMA 5 region, its center would lie close, in plan, to the

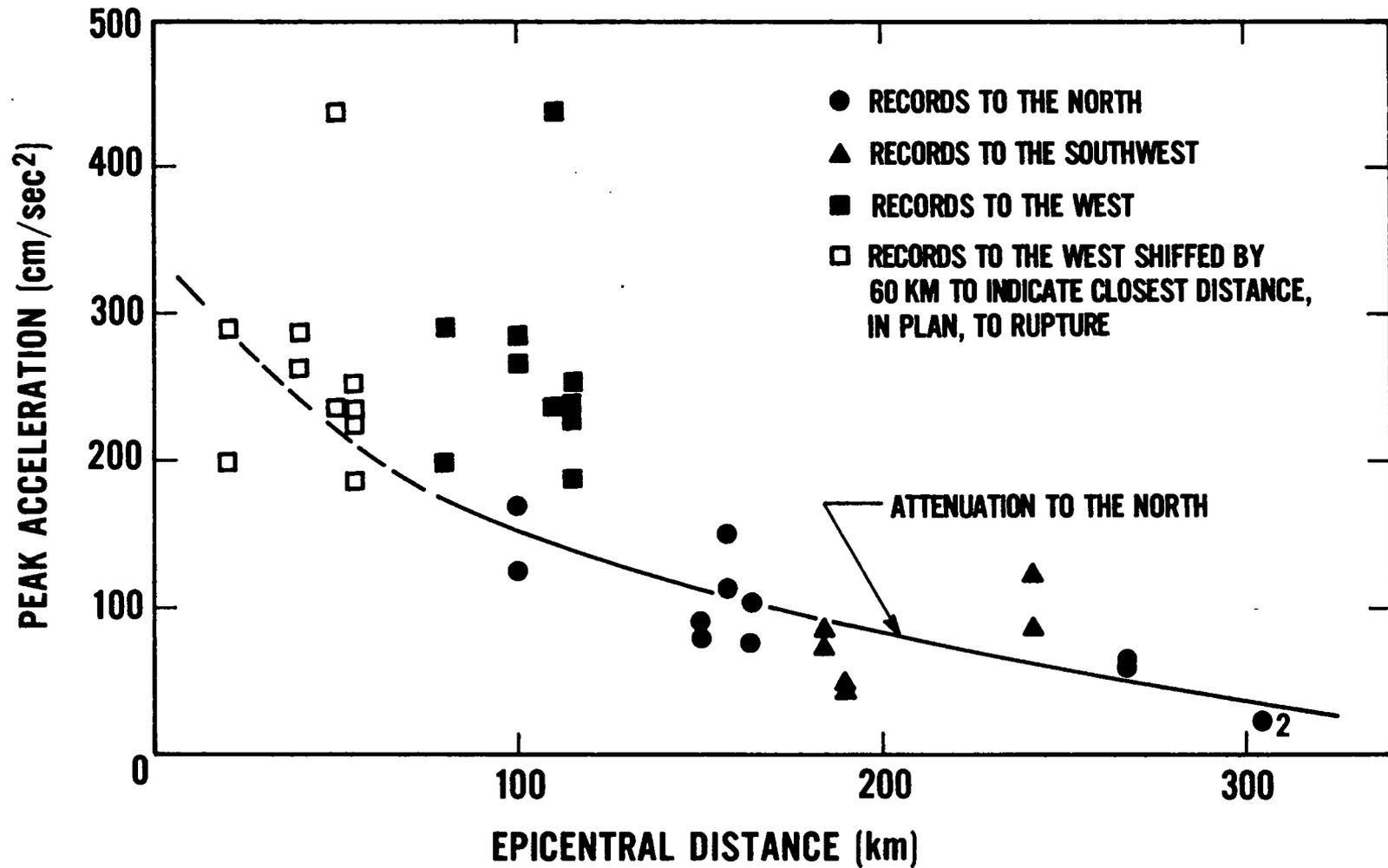


Figure 4.2 Attenuation of ground level peak accelerations with epicentral distance. The effect of shifting the points for records west of the epicenter to correspond to the distance to the closest rupture on the fault is shown.

Table 4.2 JMA Intensity Scale

- 0: Not felt. Shocks too weak to be felt by humans and registered only by seismographs.
- 1: Slight. Extremely feeble shocks felt only by persons at rest, or by those who are observant of earthquakes.
- 2: Weak. Shocks felt by most persons; slight shaking of doors and Japanese latticed sliding doors (shoji).
- 3: Rather strong. Slight shaking of houses and buildings, rattling of doors and shoji, swinging of hanging objects like electric lamps, and moving of liquids in vessels.
- 4: Strong. Strong shaking of houses and buildings, overturning of unstable objects, and spilling of liquids out of vessels.
- 5: Very strong. Cracks in sidewalks, overturning of gravestones and stone lanterns, etc.; damage to chimneys and mud and plaster warehouses.
- 6: Disastrous. Demolition of houses, but of less than 30% of the total, landslides, fissures in the ground.
- 7: Very disastrous. Demolition of more than 30% of the total number of houses, intense landslides, large fissures in the ground and faults.

westernmost down-dip end of the inferred rupture surface mentioned above. This lends credence to the conclusion that for this earthquake the distance from points on the ground surface to the nearest point of the rupture surface is the distance of importance in attenuation and related studies.

4.5 RECORDS FROM STRUCTURES

The Prompt Report (NRCDP, 1978) lists 191 strong motion records of the earthquake at epicentral distances ranging from 80 km (TH016 - Kaihoku Bridge) to almost 600 km, and includes records from 46 multi-instrumented structures such as buildings, bridges, and dams. About 100 of these records are from multi-instrumented buildings in the Tokyo area, at epicentral distances between 355 and 370 km. Although ground level accelerations here are low, some structural records have peaks of 10 percent g.

A selection of 22 instrumented structures are listed in Tables 4.3 to 4.6 with their instrument locations and peak accelerations at the various levels. Table 4.3 lists two low-rise buildings with less than six stories, Table 4.4 lists five medium height buildings between six and fifteen stories, Table 4.5 lists nine high-rise buildings with more than 15 stories, and Table 4.6 lists five bridges and a dam. All structures included in the tables have an associated ground level or basement record, and some of these have been included in Table 4.1 in the earlier section on ground level records.

The lists include the names, addresses and coordinates of the stations. Buildings are described by the number of stories above and below ground, while bridges, and the dam, have their length and width listed. The instrument locations in the buildings are indicated by story, including basement and penthouse or roof. For the bridges and dam the ground level recording station is usually off to one side of the structure on firm ground, while the structural recording station is usually on a pier cap, effectively at deck height. The peak accelerations at the listed instrument locations are given in cm/sec/sec (or gals) in groups of three - two horizontal and vertical component. Although the horizontal components are often listed as N-S and E-W in Japanese literature, these component names may actually be translated to mean the longitudinal and transverse axes of the recorder, and therefore also the longitudinal and transverse directions of the structure.

Table 4.3 Low-Rise Buildings (<6 Stories)

Site No.	Name	Address	Lat. & Long.	Number of Stories (above/below the G. L.)	Epicentral Distance (km)	Instrument Locations	Peak accelerations (cm/sec ²) 2 horiz. + 1 vert. at each level
KT 905	Bldg. E., Coll. of Ind. Tech., Nihon Univ., Tsudanuma	Izumicho, Narashino City	140°03' 35°42'	4/1	339	B1, 1, 4, RF.	21, 18, 9/15, 19, 10/56, 76, 14/64, 79, 14
TI 043	Takenaka Technical Institute	Minamisuna 2-chome, Koto Ward, Tokyo	139°49' 35°40'	4/0	363	1F, P1F(SF)	34, 26, 8/40, 53, 9

44

Table 4.4 Medium Buildings (6-15 Stories)

TH 030 TH 903	Faculty of Engineering Tohoku University	Aramaki, Sendai City		9/0	115*	1F, 9F(9F)	240, 190, 150/980, 480, 300
TK 013	Bokuto Hospital	Kotobashi, Sumida Ward, Tokyo	139°49' 35°42'	7/1	355	1F, P1F(8F)	28, 23, 5/40, 38, 10
TK 024	Earthquake Research Institute, University of Tokyo	Yayoi, Bunkyo Ward, Tokyo	139°45' 35°42'	6/1	355	B2F, GL, 2F, P1F(7F)	18, 16, 8/24, 25, 10/38, 43, 13/75, 65, 10
TK 063	Mitsui Memorial Hospital	Kanda-Izumicho, Chiyoda Ward, Tokyo		14/1	360	B1F, 7F, P1F(14F)	7, 10, 4/16, 25, 4/47, 54, 7
TK 055	Fuji Television, Head Office	Ichigaya-Kawadacho, Shinjuku Ward, Tokyo		14/2	370	B2F, 14F	18, 13, 3/75, -, 5

*Reduce by 60 km for plan distance to nearest rupture.

Table 4.5 High-Rise Buildings (<15 Stories)

Site No.	Name	Address	Number of Stories		Epicentral Distance (km)	Instrument Locations	Peak accelerations 2 horiz. + 1 vert. at each level
			Lat. & Long. (above/below the C. L.)				
TII 038	Sumitoma Sendai Building	Chudori, Sendai City		18/2	115	B2F, 9, 18	253, 227, 120/393, 520, 207/487, 553, 227
TK 039	Head Office, Fuji Bank, Ltd.	Ohtemachi, Chiyoda Ward, Tokyo	139°46'E 35°41'N	16/4	360	B4F, 8, 16	15, 13, 8/63, 43, 13/108, 85, 11
TH 050	Kasumigaseki Building	Kasumigaseki 3-chome, Chiyoda Ward, Tokyo	139°45'	36/4	360	B3F, 3, 13, 23, RF	11, 11, 11/15, 15, 7/25, 23, 11/24, 21, 18/25, 24, 34
TK 074	Hotel Grand Palace	Iidabashi 1-chome, Chiyoda Ward, Tokyo	139°45' 35°41'	24/4	360	1F, P1F(25F)	19, 19, 13/44, 58, 20
TK 058	Fuji Photo Film Co.	Nishi-Azabu 2 chome, Minato Ward, Tokyo		18/3	370	B3F, 7, 18	6, 11, 3/25, 23, 6/39, 40, 5
TK 070	Hotel Pacific Tokyo	Takanawa 3-chome, Minato Ward, Tokyo	139°44' 35°37'	29/3	370	B3F, 5, 20, 30	19, 13, 13/44, 19, 6/--/94, 38, 38
TK 104	International Communication Center	Nishi-Shinjuku 2-chome, Shinjuku Ward, Tokyo	139°41' 35°41'	36/3	370	B3F, 7, 15, 24, 33	13, 12, 9/28, 25, 9/25, 32, 10/23, 16, 15/35, 42, 19
TK 105	Shinjuku Mitsui Building	Nishi-Shinjuku 2-chome, Shinjuku Ward, Tokyo	139°41' 35°41'	55/3	370	B3F, 13, 28, 42, P1F(RF)	11, 9, 7/30, 19, 12/32, 16, 20/20, 15, 26/36, 23, 28
KI 008	Hotel Empire	Matanocho, Totsuku Ward, Yokohama City	139°30' 35°23'	22/2	390	B2F, 9, 22	15, 14, 6/60, 33, 13/158, 128, 18

*Reduce by 60 km for plan distance to nearest rupture.

Table 4.6 Bridges and Dams

Site No.	Name	Address	Lat. & Long.	Length & Width	Epicentral Distance (km)	Instrument Locations	Peak accelerations 2 horiz. + 1 vert. at each level
TH 016	Kaihoku Bridge	Inai, Ishinomaki City	141°18' 38°26'	l=285m w=6m	8km*	GL, pier cap 2	200,294,113/>500,338,188
TH 032	Mazaki Bridge	Taro Town, Iwate Prefecture	141°57'E 39°46'N	l=150m w=8m	164	GL, pier cap 1	104,75,30/119,299,45
TH 015	Yuhei Bridge	Jumonji Town, Akita Prefecture	140°28' 39°12'	l=456m w=6m	185	GL, pier cap 8	25,34,13/35,50,16
TK 021	Taira Bridge	Taira-Kamada, Iwaki City	140°54' 37°03'	l=141.6m w=14m	185	GL, abutment crest	75,88,38/56,38,25
KT 021	Shin-Tonegawa Bridge	Kurihashi Town, Saitama Prefecture	139°42' 36°08'	l=654m w=7.25m	285	GL, pier cap 7	23,40,10/35,31,10
KT 030	Tonegawa Estuary Dam	Omigawa Town, Chiba Prefecture	140°40'E 35°50'N	l=834m w=16.5m	305	GL, gate 4	45,37,15/82,89,10

*Reduce by 60 km for plan distance to nearest rupture.

The investigating team inspected three of the structures on these lists: the Faculty of Engineering Building at Tohoku University, Aramaki, Sendai, described in a later section of this chapter; the Sumitomo Sendai Building, Chuodori, Sendai, described in the chapter on earthquake performance of buildings; and the Kaihoku Bridge, Inai, Ishinomaki, described in damage to transportation structures.

4.6 A Comparison with the Recorded Results of the San Fernando Earthquake, 1971.

An overall comparison, from an engineering viewpoint, of the recorded strong-motion data from the San Fernando, 1971, and Miyagi-ken-oki, 1978, earthquakes can be based on the following information.

1. The San Fernando magnitude was 6.4 with a focus at a depth of 13 km, the rupture propagating to the surface at the northern edge of the large metropolitan area of the city of Los Angeles and its surrounding cities and communities. The tall buildings of the city lie between 21 and 50 km from the epicenter.

The Miyagi-ken-oki magnitude was 7.4 with a focus at a depth of 30 km, the rupture probably travelling deeper but at a shallow angle towards the metropolitan area of Sendai. The aftershock pattern indicates that the rupture on the fault possibly approached as close as 75 km to Sendai. The high rise buildings of Tokyo are 350 km and more from the epicenter and from the nearest part of the fault rupture.

2. The closest recording to the San Fernando epicenter was at Pacoima Dam, at 8 km, or 4 km from the surface faulting, where the topography is extremely complicated.

The closest recording to the Miyagi-ken-oki epicenter was the ground level instrument at Kaihoku Bridge at 80 km. The closest distance to the rupture, at depth, however, is closer to 60 km and this distance in plan is 20 km. The peak acceleration recorded here was 0.29g.

3. At San Fernando, the next closest record was a 7-story building, the Holiday Inn at 8244 Orion, Los Angeles, with ground level accelerations of 0.27g.

At Miyagi-ken-oki the two buildings with complete instrumentation, that is at least two recorders including the lowest level of the structure, are at epicentral distances of 115 km, which reduce to 75 km to the nearest fault rupture, or 55 km in plan. Peak accelerations at ground level range up to 0.25g. None of these buildings, in either earthquake, suffered any severe structural damage; minor cracks in columns was the extent of the observed damage to structural members.

4. A total of 35 buildings higher than six stories produced complete sets of records from the San Fernando event at epicentral distances from 24 to 50 km, and ground accelerations ranging from 0.26g down to 0.04g. Minor cracking of structural members and extensive damage to nonstructural components were common.

The Miyagi-ken-oki event produced no further sets of records from tall buildings until the Tokyo area was reached, at epicentral distances of 340 to 370 km where acceleration amplitudes were .03g and less.

5. Recordings sufficient to give a useful engineering indication of ground accelerations and associated structural performance exist for San Fernando at epicentral distances from 20 km out to 75 km.

The same type of information for Miyagi-ken-oki ranges in distance from 80 km (reduced to 60 km, see above) out to about 200 km. Structures involved here are bridges, with ground level and pier cap accelerations, and various harbor installations.

6. The San Fernando records have been the basis for a large number of engineering and seismological studies, particularly, of course, the digitized versions of the records. Even now, there are still complete sets of building records that could be analyzed to study particular building behavior.

4.7 Tohoku University, Engineering Building

Tohoku University is situated in the northwest part of Sendai, in the district of Aramaki, an area of hills and steep terrain. The Engineering Building is a reinforced concrete framed structure and is built on a reasonably flat area, but a steep cliff falls off close to the rear of the building. Figure 4.4 is a photograph of the central 9-story tower and also shows the two lower levels which cover a larger plan area. A floor plan and two elevations are shown in Figure 4.5. Two SMAC-M instruments are installed in the building, at ground level (there is no basement), and at the 9th floor level. They are on the same vertical line, against an exterior wall of the central tower, as shown in Figure 4.5. These instruments record on FM analog tape, and functioned correctly during the earthquake.

The analog tape recordings were recovered and analyzed by the Building Research Institute, which was responsible for the instruments. After analog-to-digital conversion, a computer analysis was possible, and was completed within seven days (Watabe, 1978). The following figures are reproduced from the preliminary work.

Figure 4.6 shows a 25-sec portion of the record from the ground level instrument, after A/D conversion. The peak horizontal accelerations are 240 and 190 cm/sec/sec, and the peak vertical acceleration is 150 cm/sec/sec, as indicated in Table 4.1. Figure 4.7 shows a similar plot of the 9th floor record peak values of 980, 480, and 300 cm/sec/sec (Table 4.4). A preliminary analysis of the high-amplitude oscillations in the horizontal directions at this level indicate that the corresponding displacements are approximately 10 in (25.4 cm). This is consistent with the damage in the interior of the building, (discussed in Chapter 5), and indicates the building was approaching the structural damage state.

Figures 4.8, 4.9 and 4.10 show the correction procedures applied to the three ground level components. Acceleration velocity and displacement are plotted. Figures 4.11, 4.12, and 4.13 show spectral analyses performed on these records. The analyses include absolute acceleration response, relative velocity response, relative displacement response, and pseudo velocity response, the last being plotted in the tripartite 3-way response spectrum style.

4.8 Tracings of Records

Tracings of sections of the records from some of the closer stations are included. Figure 4.14 is the ground level record on the premises of Shiogama Harbor Office, site No. TH033, with peak values scaling off at 266, 288 and 166 cm/sec/sec. The arc-shaped curves drawn by the hinged arms are clearly evident on the high-amplitude excursions. Figure 4.15 shows the ground level record for site No. TH019, the breakwater of Ofunato Harbor, with peak values of 126, 170 and 61 cm/sec/sec. The amplitudes here are sufficiently high in a few instances to show their arc-shaped character. Figure 4.16 shows the first basement record at the JNR building at Sendai. The peak NS reading of 438 cm/sec/sec is the highest ground level amplitude in the city. The building has six stories, but no record was recovered from the station at the sixth floor. Consequently it is difficult to analyze this basement record and to ascertain the extent of the interaction between building and ground.

4.9 References

- 4.1. National Research Center for Disaster Prevention; Science and Technology Agency (Japan), March 1976, Strong-motion earthquake records in Japan, 1974, vol. 19.
- 4.2. National Research Center for Disaster Prevention, July 1978, June 12, 1978, Miyagi-ken-oki Earthquake: National Research Center for Disaster Prevention; Science and Technology Agency (Japan), Prompt Report on Strong-Motion Accelerograms No. 15.
- 4.3. Wood, H. O., and Newman, F. (1931). Modified Mercalli Intensity Scale of 1931, bull. Seism. Soc. Am., 21, 277-283.
- 4.4. Trifunac, M. D., and Brady, A.O. (1975). On the correlation of seismic intensity scales with the peaks of recorded strong ground motion, Bull. Seism. Soc. Am., 65, 1, 139-162.



Figure 4.4

Engineering Building,
Tohoku University,
Aramaki, Sendai.

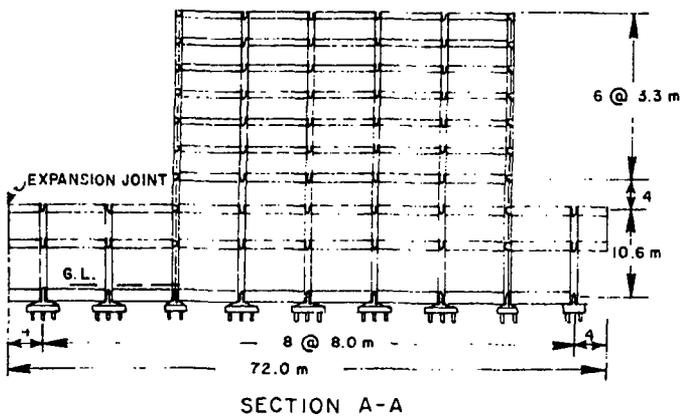
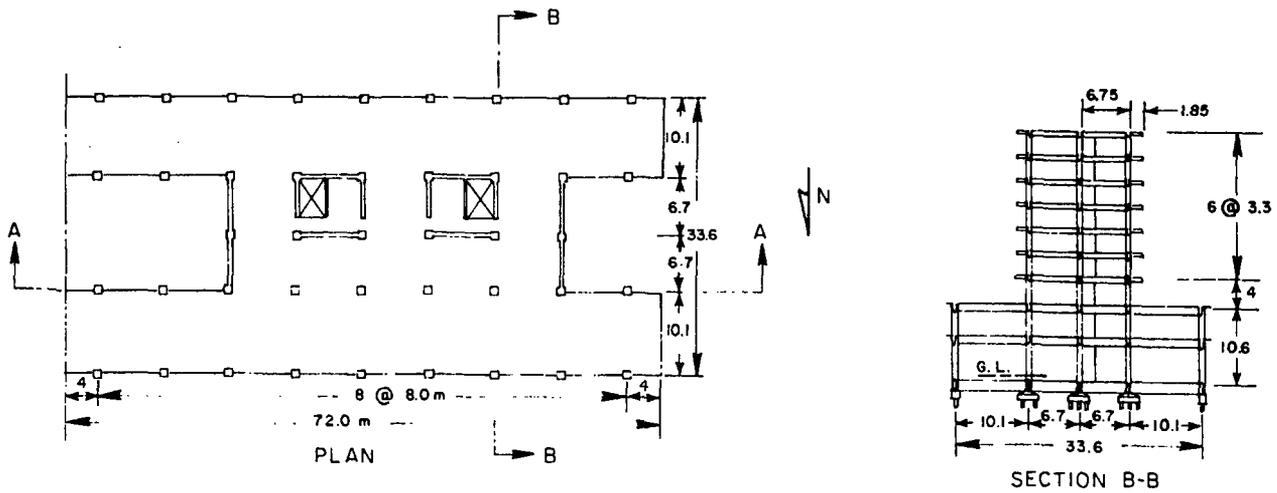


Figure 4.5

Floor plan and sections of
the Engineering Building

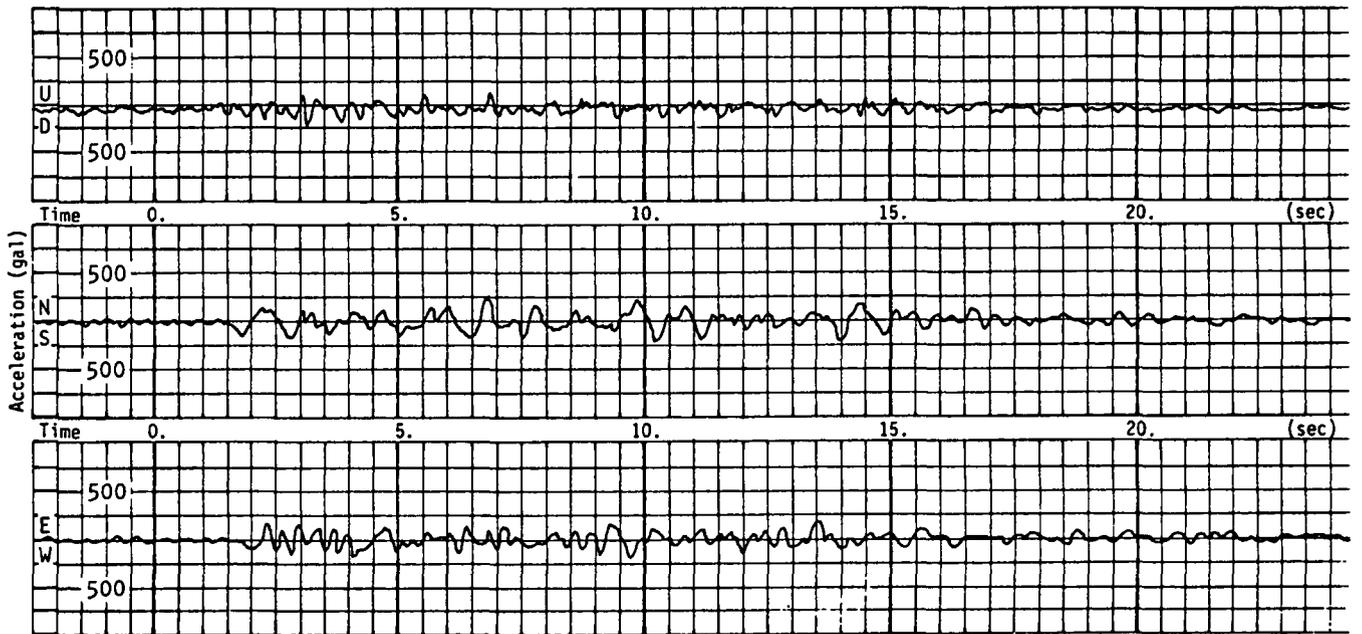


Figure 4.6 Three components, after analog-to-digital conversion, at 1st floor level, Engineering Building.

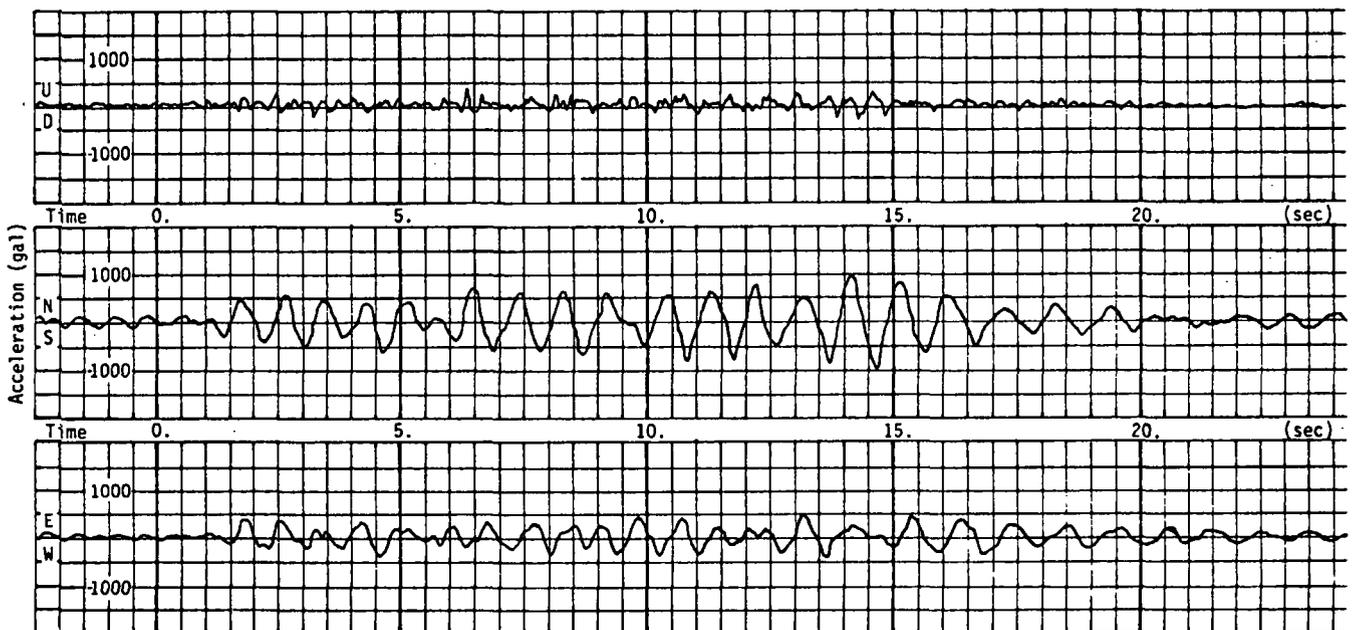
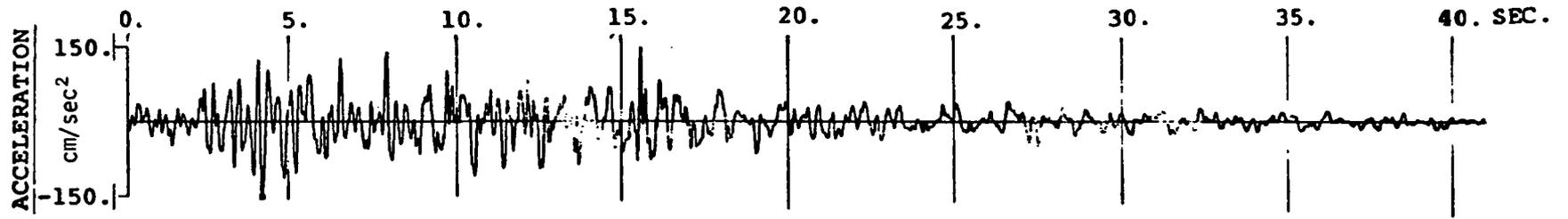
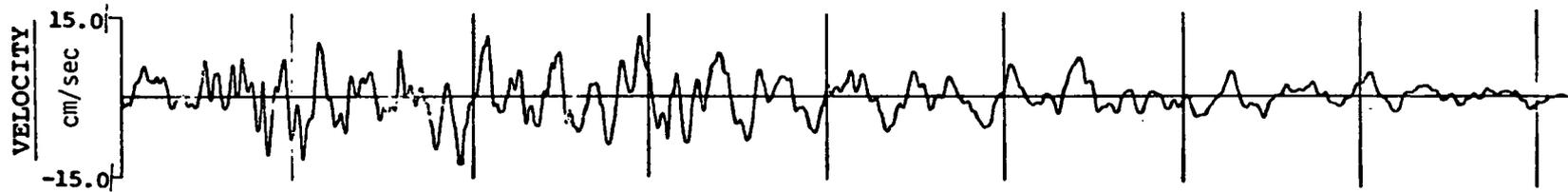


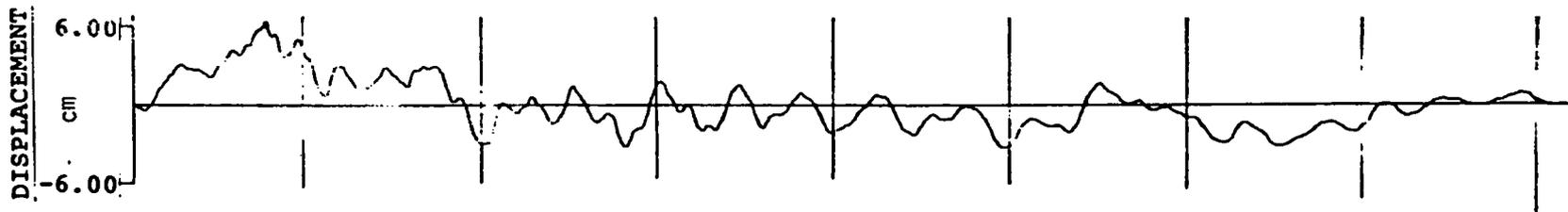
Figure 4.7 Three components at 9th floor level, Engineering Building.



MAX. VALUE= 152.9888 AT 4.1800 SEC.



MAX. VALUE= 12.2492 AT 9.7000 SEC.



MAX. VALUE= 6.1533 AT 3.8800 SEC.

Figure 4.8 Corrected acceleration, velocity, displacement for 1st floor, up-down component, Engineering Building.

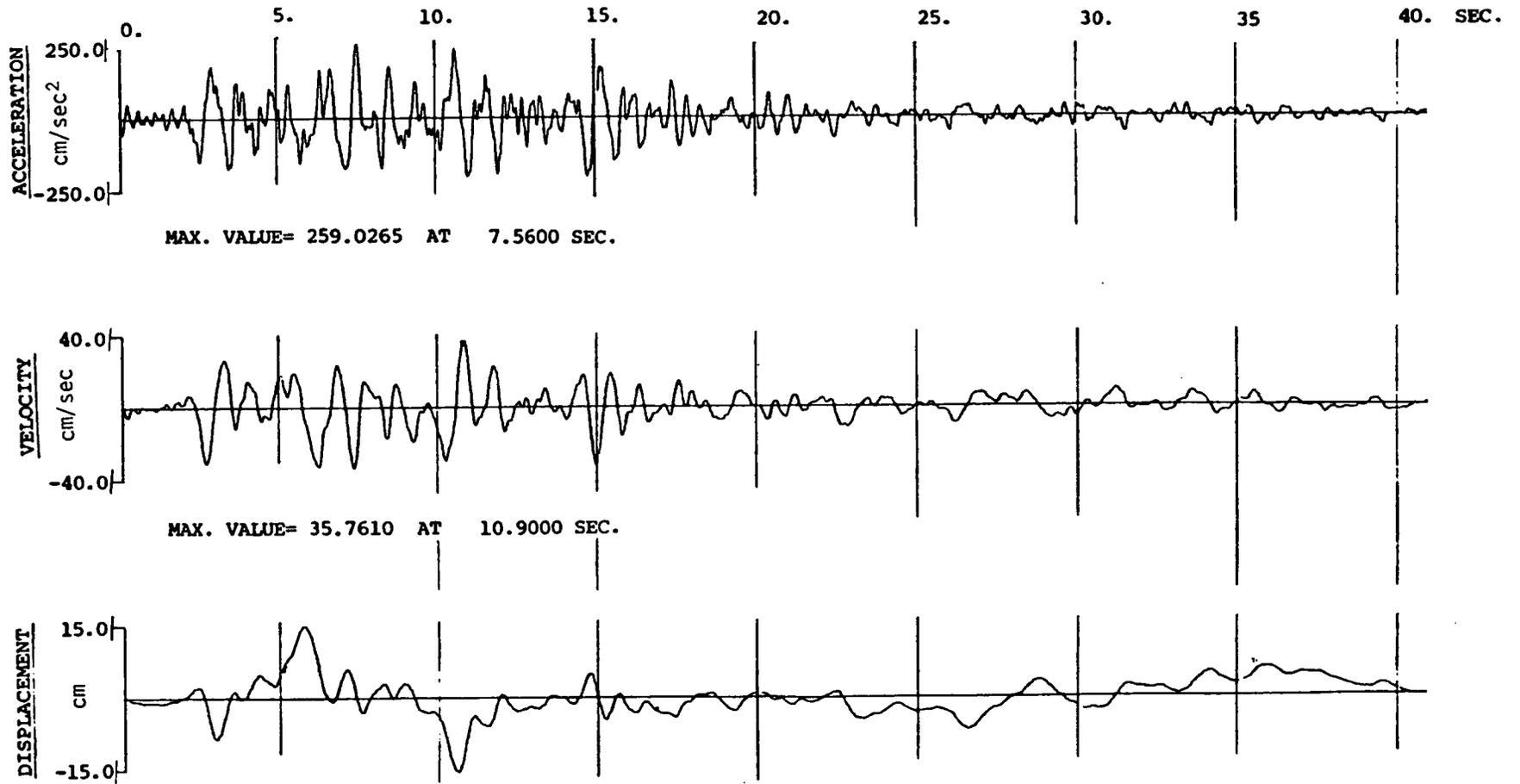
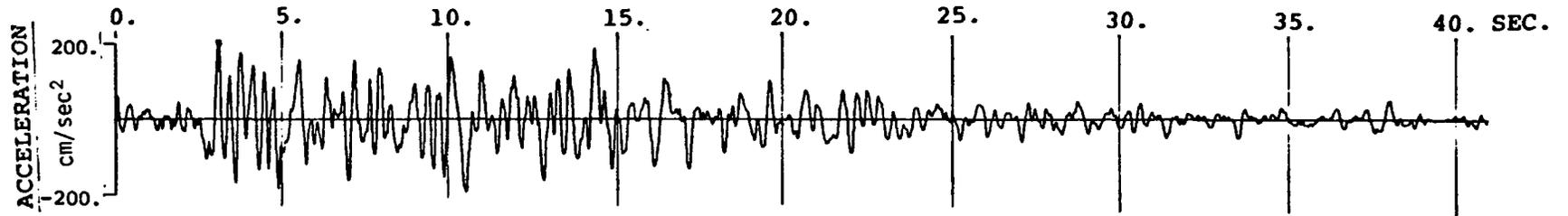


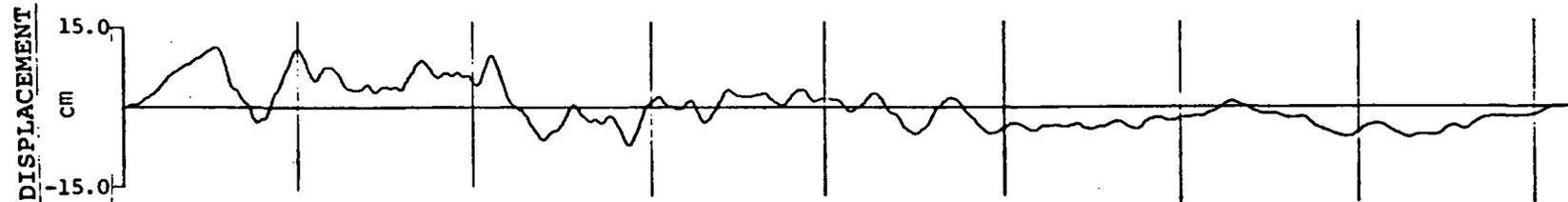
Figure 4.9 Corrected acceleration, velocity, displacement for 1st floor, north-south component, Engineering Building.



MAX. VALUE= 202.6549 AT 3.1000 SEC.



MAX. VALUE= 26.5594 AT 2.9600 SEC.



MAX. VALUE= 11.4080 AT 2.6200 SEC.

Figure 4.10 Corrected acceleration, velocity, displacement for 1st floor, east-west component, Engineering Building.

TOHOKU UNIVERSITY ENGINEERING BUILDING , JUNE 12, 1978 , 1st FLOOR, UP - DOWN

DAMPING : 0, 2, 5, 10, 20% CRITICAL

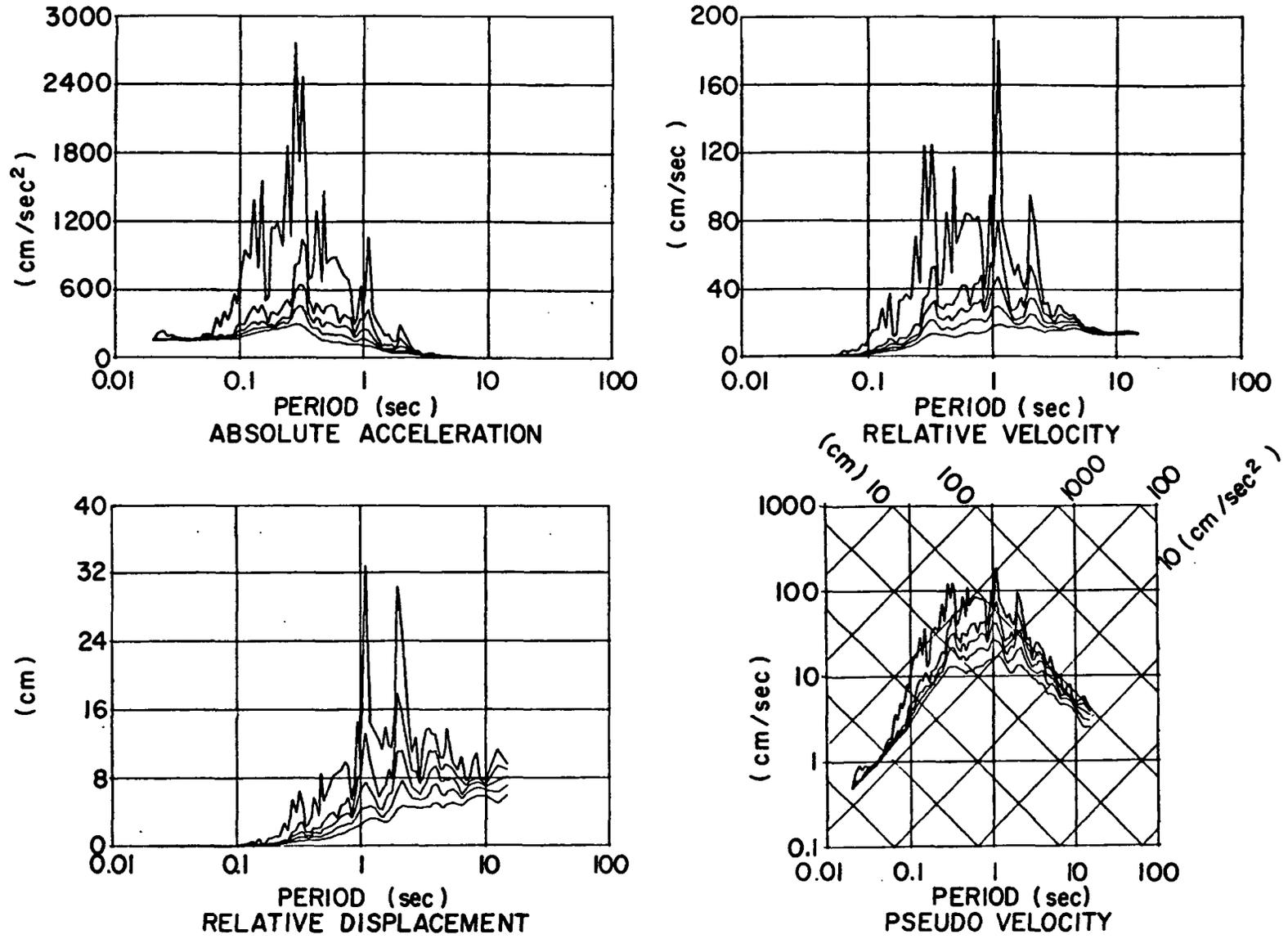


Figure 4.11 Spectra, 1st floor up-down component

TOHOKU UNIVERSITY ENGINEERING BUILDING , JUNE 12, 1978 , 1st FLOOR, NORTH-SOUTH

DAMPING : 0, 2, 5, 10, 20 % CRITICAL

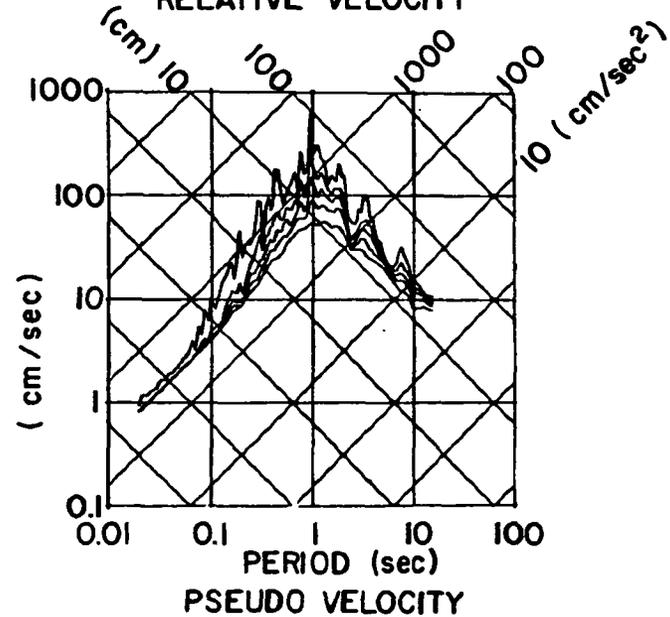
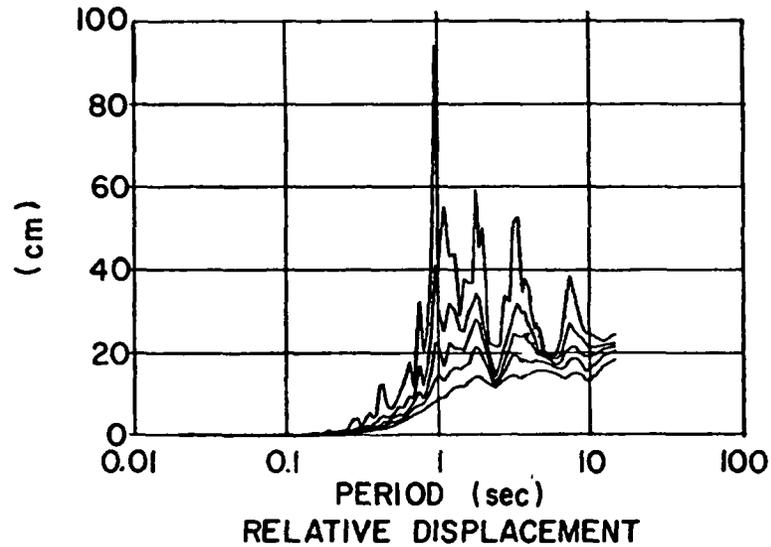
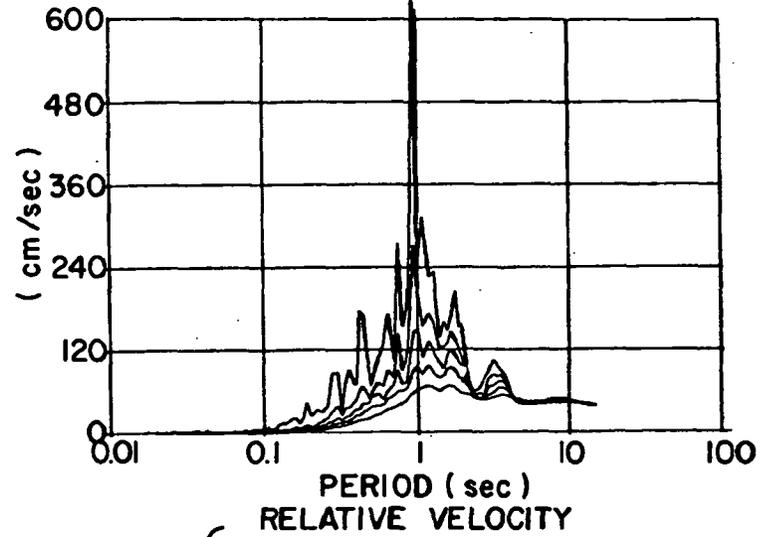
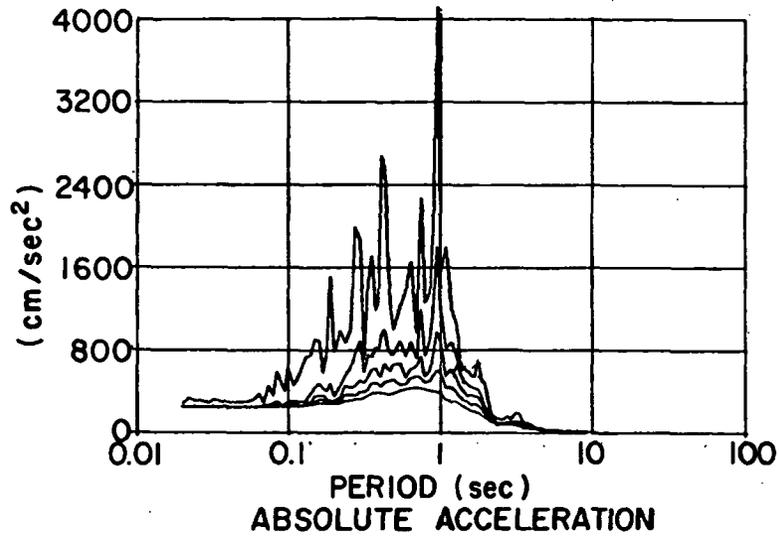


Figure 4.12 Spectra, 1st floor north-south component

TOHOKU UNIVERSITY ENGINEERING BUILDING , JUNE 12, 1978 , 1st FLOOR, EAST - WEST

DAMPING : 0, 2, 5, 10, 20 % CRITICAL

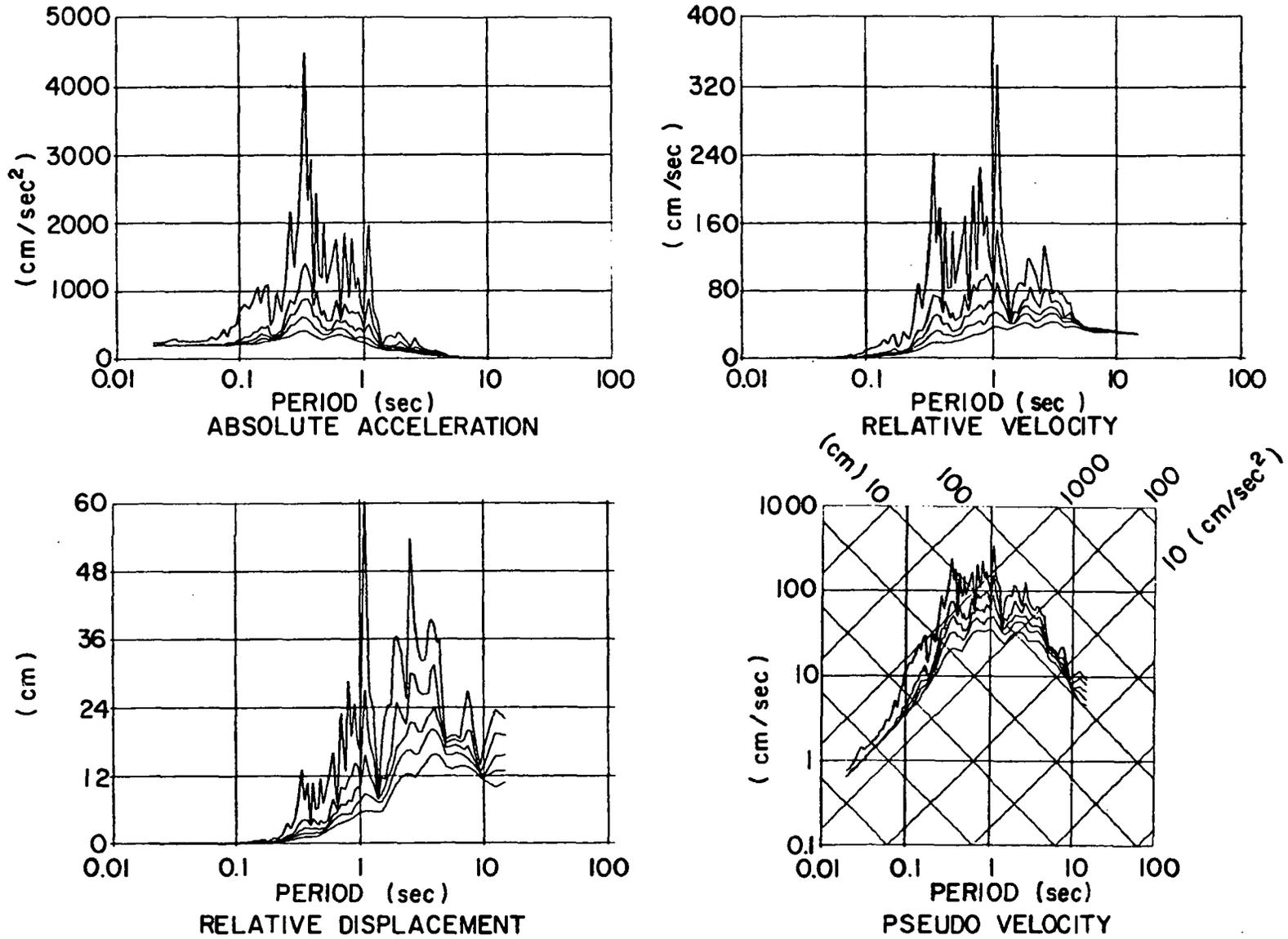


Figure 4.13 Spectra, 1st floor east-west component.

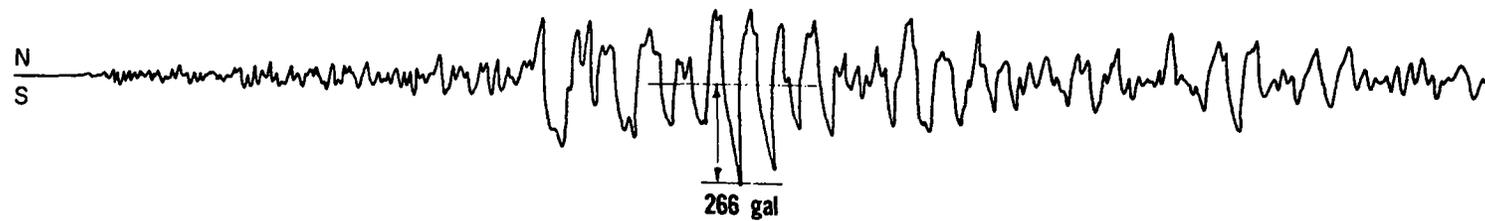
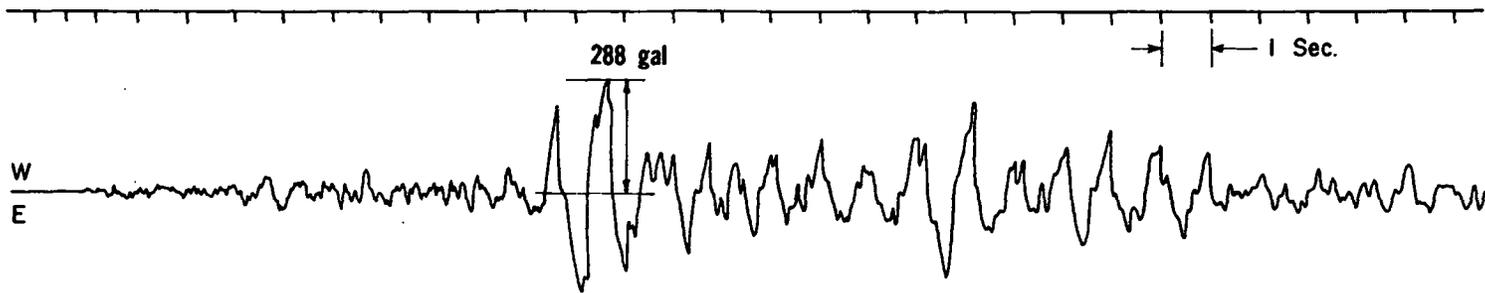


Figure 4.14 Tracing of portion of record from TH033 Shiogama.

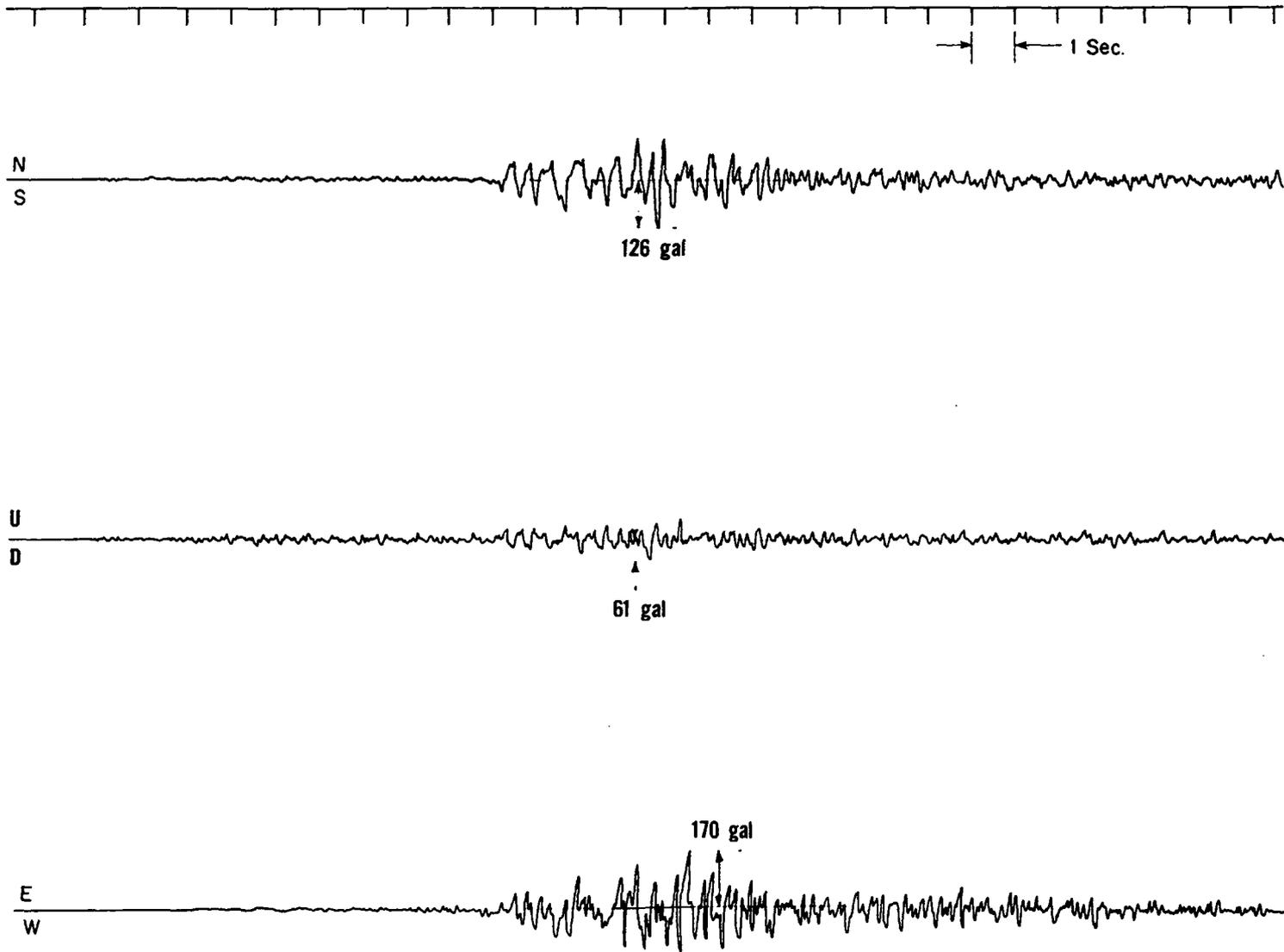
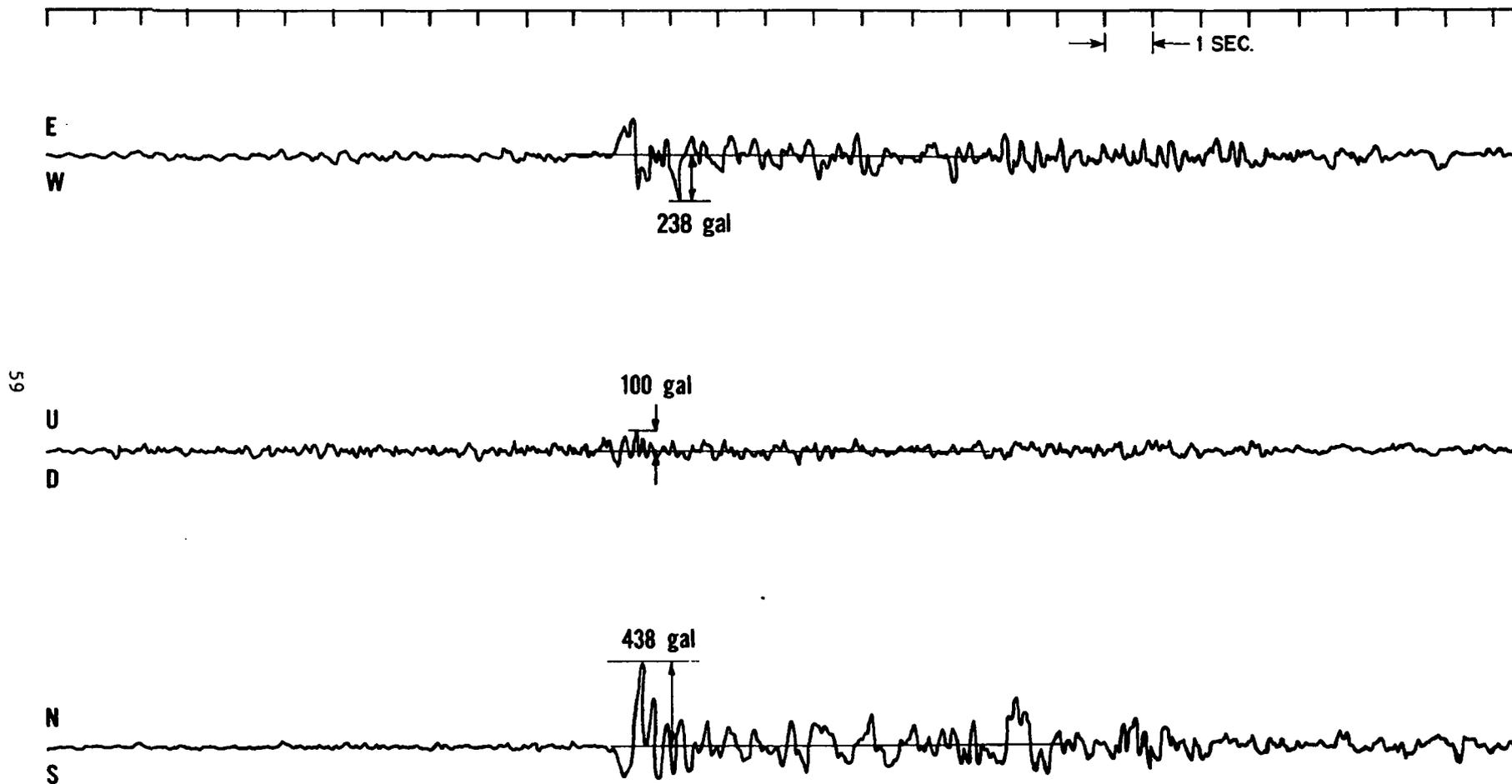


Figure 4.15 Tracing of portion of record from TH019 Ofunato.



59

Figure 4.16 Tracing of portion of record from TH018
JNR Building, Sendai, 1st basement.

- 4.5. Kuribayashi, E., Tsuchida, H., and Watabe, M. (1975). Maintenance of the Strong Motion Accelerograph and Data Processing of Records Obtained, Proc. 7th Conference UJNR Wind and Seismic Effects, May 1975, Tokyo, Japan.
- 4.6. Iwasaki, T., Katayama, T., Kawashima, K., and Saeki, (1978), Statistical Analysis of Strong Motion Acceleration Records Obtained in Japan. Proc. 2nd Int. Conf. on Microzonation, November 1978, San Francisco, Calif., USA.
- 4.7. Watabe, M., 1978. Personal communication, and tentative report by Building Research Institute.

5. EARTHQUAKE PERFORMANCE OF BUILDINGS*

5.1 Introduction

As shown in the aerial photograph in Figure 5.1 and in Figure 5.2, Sendai is a large modern city. It is the center for commerce and industry for Miyagi Prefecture. Many buildings in the city can be considered to be modern highrises, in excess of five to six stories. In particular, the downtown center of the city has a multitude of modern buildings in the 10- to 20-story range. The map in Figure 5.3 shows the metropolitan Sendai area; Table 5.1 identifies the points of interests on the map.

The U.S. team arrived in Sendai June 23rd, 11 days after the earthquake. The first impression upon entering the city was that a significant earthquake had not even occurred. This was due in part to the speed with which the Japanese authorities had responded to the disaster. Evidences of damage that would have otherwise impeded the normal operations of the city had already been cleared away. Upon closer inspection, minor facade damage became obvious (Figures 5.4, 5.5, 5.6, and 5.7. This sort of damage was not widespread by any means and numerous modern buildings did not show any damage to their architectural veneers or glazing. It was reported that many chimneys and stacks had collapsed or were severely damaged (e.g., Figures 5.8 through 5.10).

As the investigation proceeded, it became obvious that numerous pockets of damage existed throughout the city. These apparently are correlated to the local geological and soil conditions, discussed in Chapter 3. Soil conditions in the downtown Sendai area (Figure 5.3, within 2 km N and W of the railway station) generally are quite good. Many highrises in this area have raft foundations and are situated on a gravel-type soil. The area to the west and south of the Hirose river are stable terrace deposits. However, the area to the east of the railroad and to the south of Japan National Highway 45 is a former agricultural area. The underlying soil is a young alluvial deposit, and from an engineering point of view, the soil conditions are quite poor.

This chapter begins with an overview of seismic engineering and construction practices in Japan. This will be followed by a discussion of investigations of commercial and retail establishments, schools, apartment buildings, and single family residences. Industrial facilities are covered in Chapter 6.

5.2 Seismic Engineering and Construction Practice

The general seismic design philosophy in Japan is that it is not economically feasible to provide complete protection against all earthquakes. Prevention of loss of life is the overriding concern. Thus, the design criteria are aimed at preventing structural damage and minimizing damage due to moderate earthquakes, and avoiding collapse or serious structural damage due to severe, infrequent earthquakes.

The Japan Building Code governs the design of buildings and related structures such as chimneys and elevated water towers. The method of seismic coefficients is similar in concept to the U.S. equivalent lateral force method recommended by the Uniform Building Code (1976) and other standards. It is still commonly used in Japan, particularly for buildings five stories and less in height, but it is recognized as being unsuitable for many flexible structures. Dynamic analyses are required for buildings over five stories in height.

There are a number of general guidelines and requirements, which are discussed in further detail in Refs. 5.1 - 5.4. For example seismic calculations are required in buildings of more than 100 m² floor area used for schools, hospitals, and places of public assembly, and in structures having more than two stories or 200 m² floor area. No buildings with total floor areas exceeding 3000 m² can be wood, nor can buildings in excess of 13 m in height be wood or unreinforced stone, brick or concrete block masonry, or concrete. There are additional detailing requirements that depend on the construction material.

* Prepared by Bruce Ellingwood, Center for Building Technology, National Bureau of Standards, Washington, D.C.



Figure 5.1 View of the downtown area of Sendai (Tohoku Electric Power Company photograph).



Figure 5.2 Typical buildings of the downtown Sendai area.

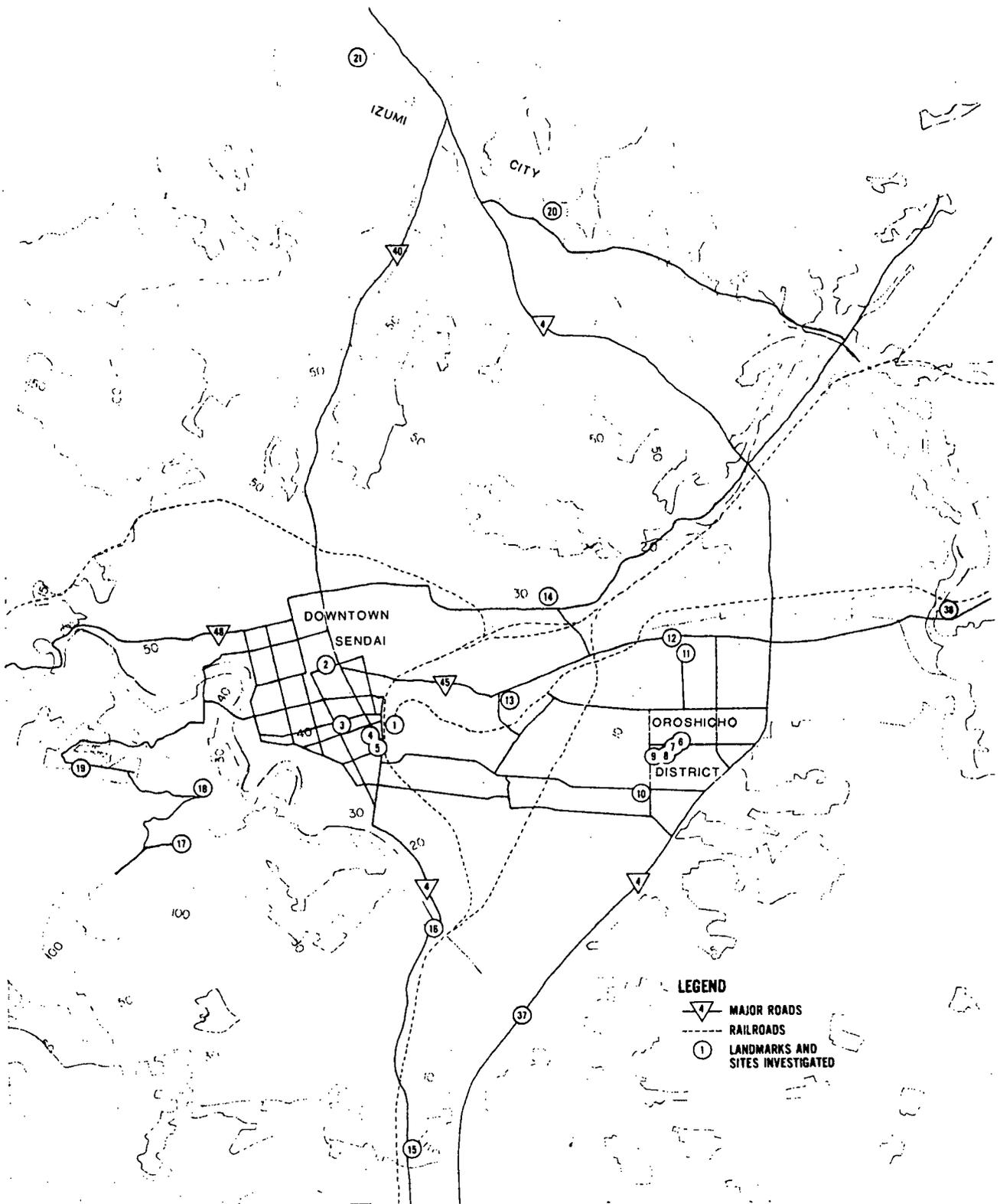


Figure 5.3 Map of Sendai City, showing major landmarks and sites of damaged structures. See Table 5.1 for identification

Table 5.1 - Numbered sites in Figures 5.3 and 6.1

1. Sendai railway station
2. Second government building
3. 77 Bank building
4. Sumitomo Insurance Building
5. Japan National Railway building
6. Maruyoshi building
7. Obisan building
8. Kinoshita building
9. Maruhon building
10. Yazaki Industries
11. Taiyo Fisheries Plant
12. Paloma Sendai building
13. Tonan High School
14. Haronamachi Gas Plant
15. Cement plant
16. Hirose Bashi Bridge
17. Tohoku Institute of Technology
18. Aoba Castle
19. Tohoku University
20. Sendai Substation, Tohoku Electric Power Company
21. Izumi City High School
22. Yuriage Bridge
23. Abukuma Bridge
24. New Sendai Power Plant, Tohoku Electric Power Company
25. Tohoku Oil Company, Ltd. refinery
26. Ono Bridge
27. Kimazuka Bridge
28. Eaigawa Railway bridge
29. Kaihoku Bridge
30. Tenno Bridge
31. Iinogawa Bridge
32. Yanalzu Bridge
33. Toyoma Ohashi Bridge
34. Maiya Ohashi Bridge
35. Kin-no Bridge
36. Kitakami Ohashi Bridge
37. Sendai Ohashi Bridge
38. Sunny Heights Apartment building

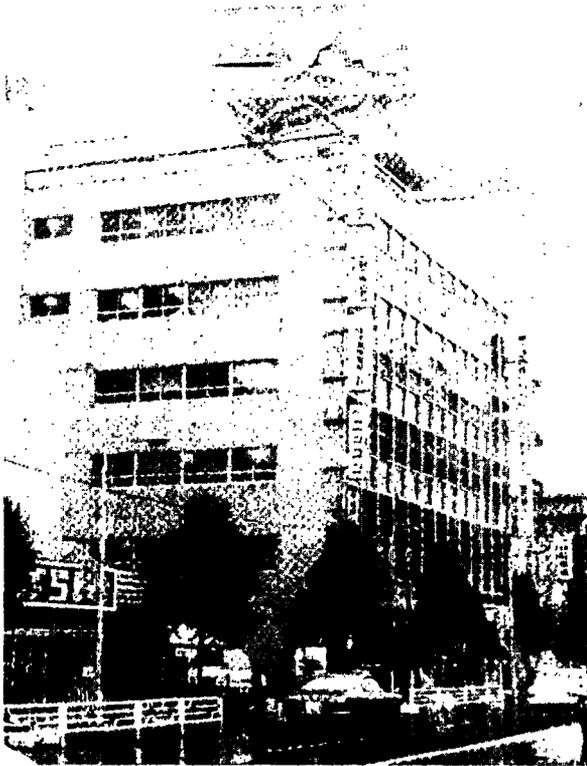


Figure 5.4 Minami Machidori Building, Sendai. The cracking to the brick veneer is typical for many similar buildings in the city.

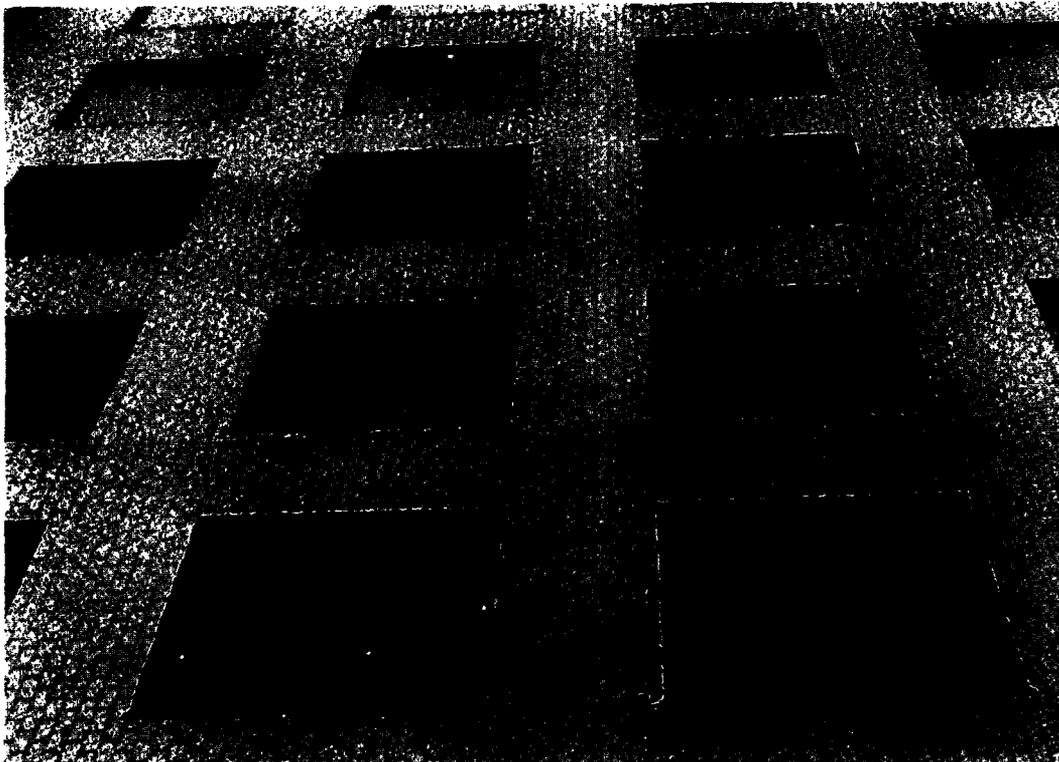
Figure 5.5 Minami Machidori Building. Closeup of the lower floors of the building.





Figure 5.6 Second Eastern Building Company Building, Sendai. A typical modern building in Sendai; the only apparant damage to the glazed tile veneer on the exterior was cracking on spandrels and shear walls.

Figure 5.7 Second Eastern Building Company Building. Closeup of exterior wall.



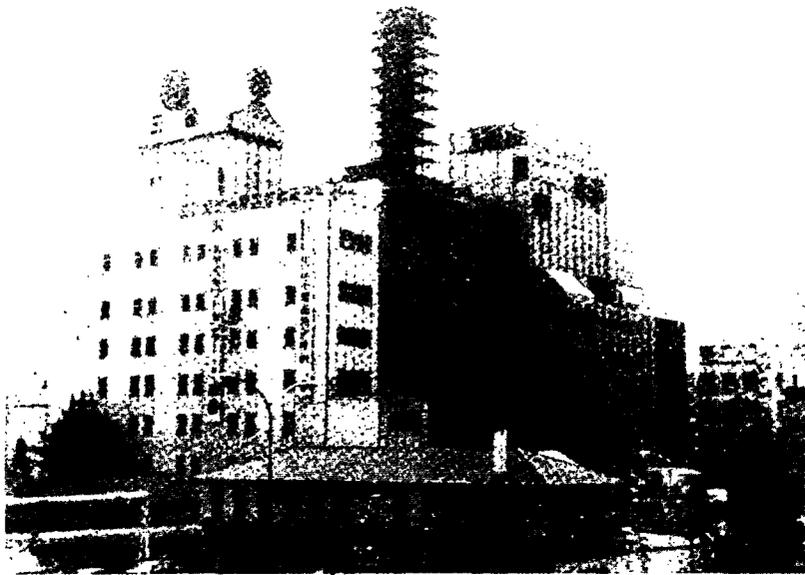


Figure 5.8 Chimney damage to the Mitsukoshi Department store. Numerous such chimneys suffered such damage.

68

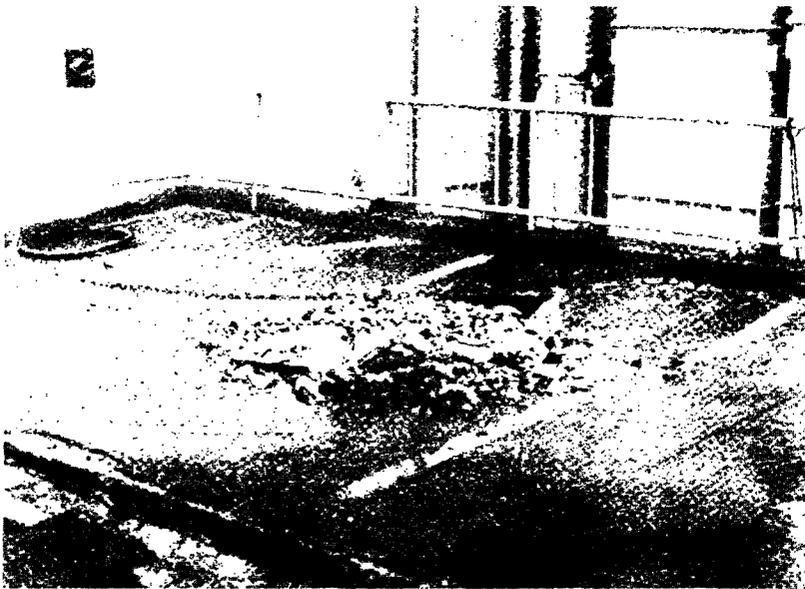


Figure 5.10 Impact area of chimney failure (see Figure 5.9)

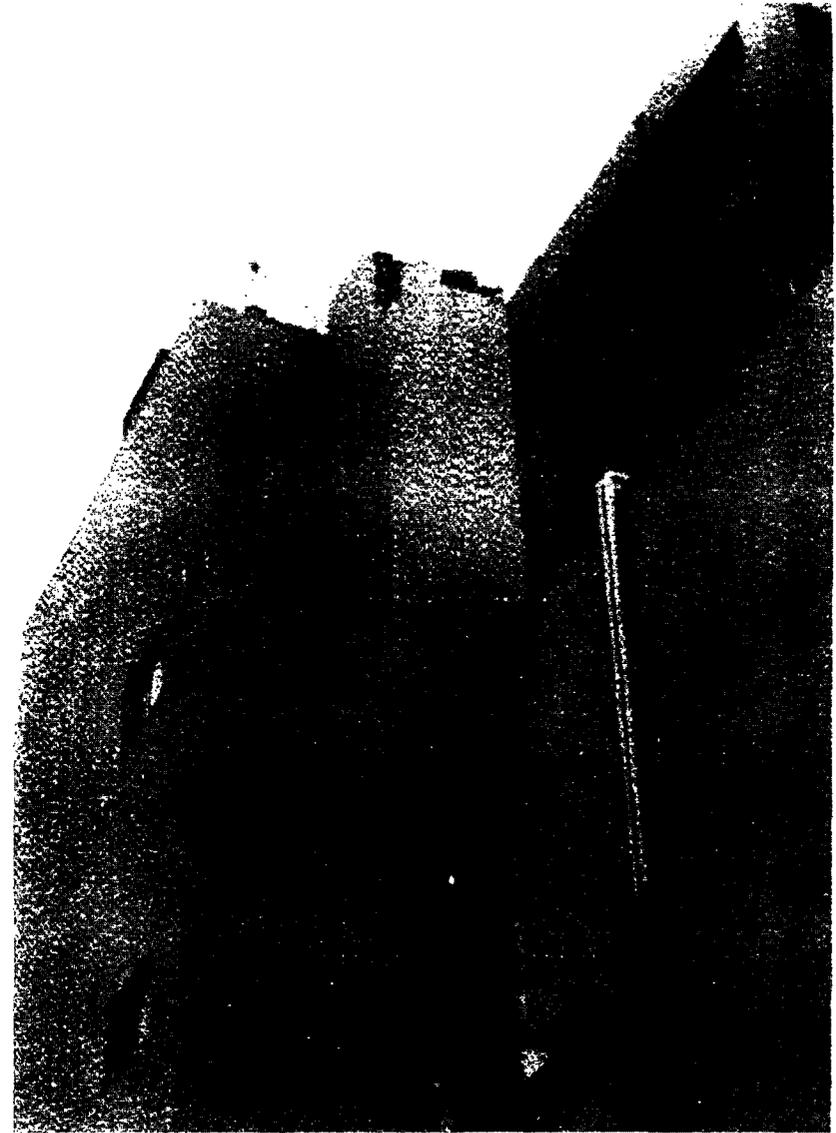


Figure 5.9 Downtown Sendai. Reinforced concrete chimney failure.

The seismic base shear V is calculated by multiplying the sum of dead and a portion of the live load by a seismic coefficient k that is calculated as the product of a standard seismic coefficient k_0 , a site seismicity coefficient k_1 and a soil and building type coefficient, k_2 . Coefficient k_1 is determined from a map, and takes into account the intensity and frequency of earthquakes anticipated for the location. For Sendai and environs, $k_1 = 0.9$. Coefficient k_2 accounts for the characteristics of the ground at the site and the probable mode of behavior of the building. The product of $k_1 k_2$ is in no case taken as less than 0.5.

This procedure is summarized as follows:

$$V = kW$$

W = Dead plus a portion of live load

$$k = k_0 k_1 k_2$$

k_0 = standard seismic coefficient

= 0.2 for heights less than 16m

= $0.2 + \frac{0.01}{4} (h-16)$ for heights greater than 16m

= 0.3 for wood structures on soft ground (alluvium greater than 30m thick, reclaimed marshes, etc.)

k_1 = Site seismicity coefficient (map provided)

k_2 = Soil and building coefficient

Values of k_2

Rock	Wood	Steel	R/C	Masonry
Sand-Gravel	0.6	0.6	0.8	1.0
Sandy Clay	0.8	0.8	0.9	1.0

Note that k_0 varies with the height of the building; however, building period does not enter the seismic force equation explicitly.

The Japan Building Code permits the allowable stresses to be increased by a factor of 100 percent for earthquake, while most standards in the U.S. permit only 33 percent increase. However, U.S. standards (e.g., Uniform Building Code, 1976 Edition) do not include live load in determining W , except for warehouse and storage occupancies. The basic force coefficient k_0 is larger than the factor C in the Uniform Building Code, to which it is analogous.

Unreinforced masonry buildings are generally two stories or less in height. A reinforced concrete collar beam must be provided at the top of each story wall, and the height-thickness ratio of walls must be less than 15.

Earthquake resistance of wooden buildings is generally provided by specifying minimum lengths of walls and diagonal bracing. The Japanese Building Code requires a minimum length of wall or a framework with diagonal bracing for wooden buildings over 50 m² in floor area and two or more stories in height. The required bracing or length of wall depends on the floor area. Bracing must be provided for horizontal floor diaphragms also. These requirements result in a structural frame that is stiffer than those found in single family dwellings in the U.S.

Earthquake resistance in steel buildings is provided either through the use of moment-resisting frames or through diagonal bracing. When braces are used as earthquake resisting elements, it is normal practice to design them so as to carry all of the horizontal force. An example of such a structure is a steel framed furniture warehouse on the outskirts of Sendai shown in Figure 5.11. There were many examples where the bracing members buckled under stress reversal or the connections failed. A number of the transverse diagonal braces used in this warehouse sheared at their bolted cross connections (Figure 5.12).

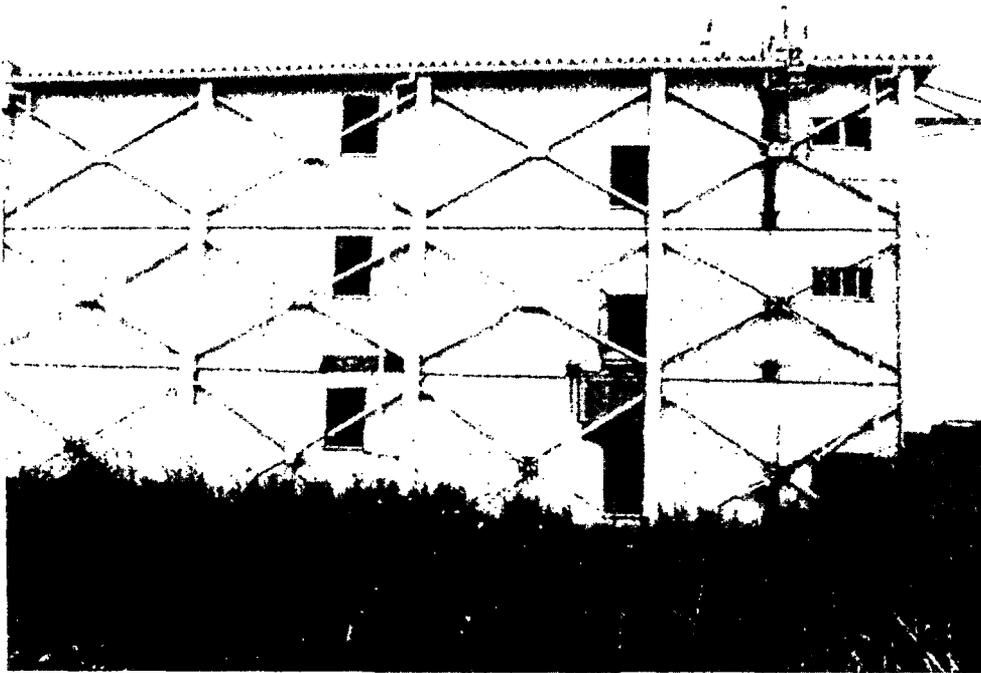
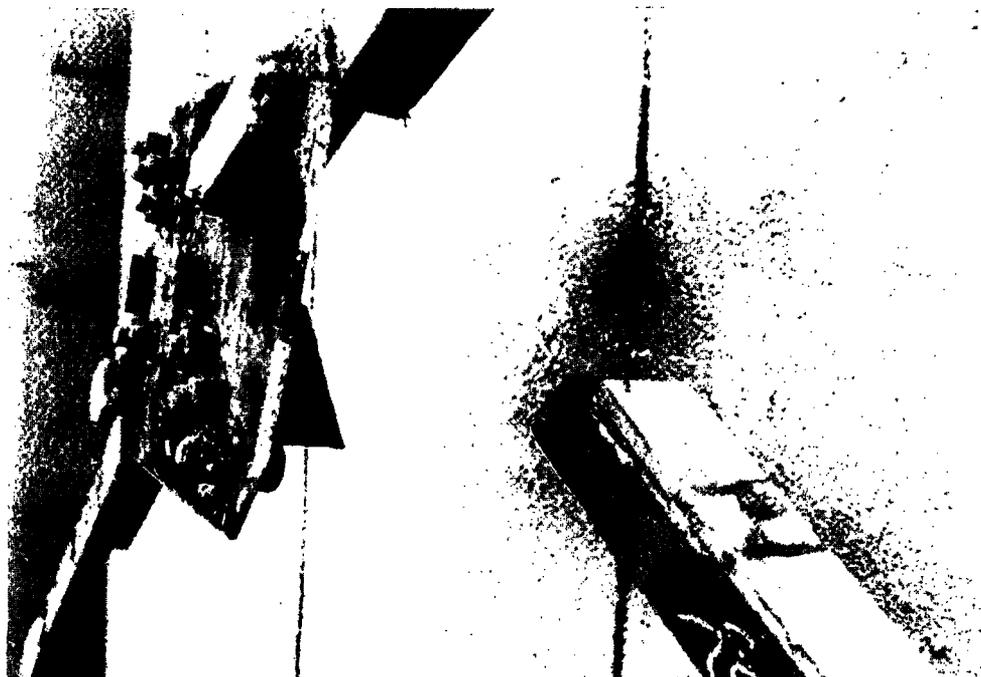


Figure 5.11 A damaged steel-framed furniture warehouse on the outskirts of Sendai.

Figure 5.12 Detail of failure in transverse diagonal braces.



Many modern high-rise buildings in Sendai have steel frames, and these generally performed very well during the earthquake. One example is the Sendai Second Government Building in the downtown area (No. 2 in Figure 5.3), a 17-story structure built in 1973 (Figures 5.13 and 5.14.) The building is situated on a raft foundation, where the underlying soil conditions are good. The frame was designed by dynamic analysis for a maximum base acceleration of 0.2 g. The building is instrumented with strong motion accelerometers at the 15th floor and second basement levels, and a downhole at 40 m below grade. The building suffered virtually no damage, although there was some minor diagonal cracking in the concrete stairwells leading to the basement.

A number of changes were made to the Japan Building Code in 1971, many of which relate to the design of reinforced concrete buildings. While the standard seismic coefficient remained 0.2, requirements for minimum spacing of column ties became more stringent in the 1971 edition. In the pre-1971 code, the maximum tie spacing in normal weight concrete columns was 300 mm or 15 times the diameter of the main reinforcement; in the new code, the maximum spacing permitted is 100 mm. The minimum allowable bar cover is 30 mm. Section A.6.5.3 of ACI Standard 318-77 (Ref. 5.7) and Chapter 11 of Ref. 5.6 have similar requirements that limit vertical spacing of ties in columns to 4 in (100 mm) at locations above and below beam-column connections. Undeformed reinforcing bars were commonly used in Japan until about 10 years ago. The 1971 Japan Building Code requires the use of deformed bars, however.

Numerous modern buildings in Japan, particularly those between six and fifteen stories, use the SRC (Steel and Reinforced Concrete) system, in which the reinforcement is provided by embedded steel shapes in conjunction with conventional reinforcing bars. The fire resistance and safety against buckling are high, while the the cross sectional dimensions of the structural members can be made smaller than in conventional reinforced concrete structures. The systems is quite ductile. The Sumitomo Insurance Building in downtown Sendai (No. 4 in Figure 5.3) is an example of such a structure (Figures 5.15 - 5.17). This is a modern 18-story SRC building with continuous reinforced concrete shear walls around the elevator core and on the outside transverse walls. The interior shear walls around the elevator core and some of the construction joints in the stairwells and nonstructural partitions showed minor diagonal cracking. However, the main structural elements are believed to be undamaged. It was reported that after the February 1978 earthquake, the Sumitomo Insurance building had diagonal cracking in secondary walls and that after the June earthquake, these had become more extensive. Vibration tests conducted before and after the February earthquake showed that the fundamental frequency decreased from 1.2 Hz to 1.0 Hz due to cracking. The structural damping also increased. The Sumitomo Insurance Building had strong motion instrumentation in the 2nd basement, the 9th and 18th floors (see Chapter 4). Peak accelerations of 0.26 g (2nd basement) and 0.56 g (18th floor) were recorded during the June 12 earthquake.

The 77 Bank Building is located in downtown Sendai not far from the train station (No. 3 in Figure 5.3). An exterior elevation and a floor plan are shown in Figures 5.18 and 5.19. The basements and first three stories are SRC, while the remainder has a steel frame. Like many of the high-rises in the main area of the city, it has a raft foundation. As shown in the plan, the building has an eccentrically located elevator core, surrounded with reinforced concrete shear walls. A quick walk-through inspection revealed no signs of damage to interior columns, their stucco panel facing, or the marble veneer in lower story corridors. The building was completed in 1977 (hence its name), and was designed according to the 1971 seismic code.

5.3 Commercial and Retail Establishments

The map of Sendai in Figure 5.3 shows a shaded area east of the railroad tracks and south of Japan National Highway 45. Until about 10 years ago, this was an agricultural area that was mainly rice paddies. The water table is known to be quite high and, from an engineering point of view, the soil conditions are poor. There are numerous buildings in the two- to four-story range which are used for small business, retail, and other commercial establishments. These buildings typically have a ground-story used to display merchandise with large open areas and few walls. The upper floors are used for offices and for storage. This type of building layout creates a structure in which walls are not placed symmetrically with respect to the center of the structure and in which the first-story lateral force-resisting elements are relatively flexible when compared with the upper portions of the structure.

Figure 5.13 Sendai Second Government Building. This modern steel frame structure suffered no damage.

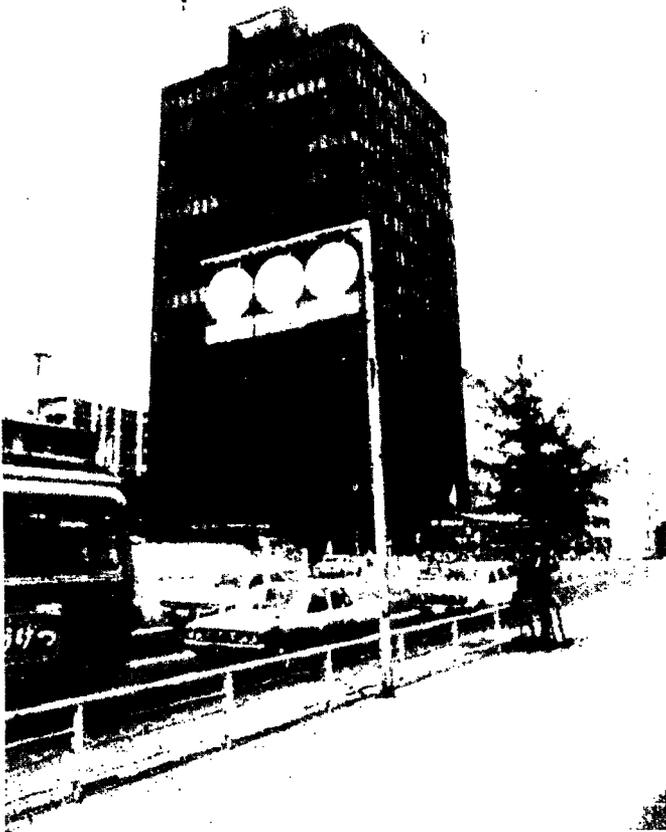
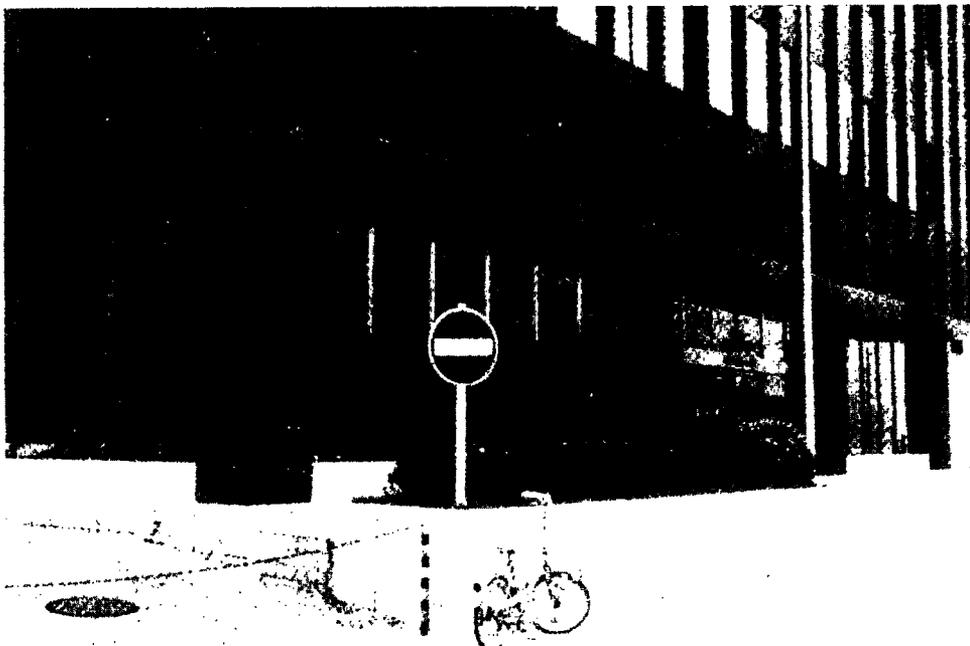


Figure 5.14 Sendai Second Government Building, ground level.



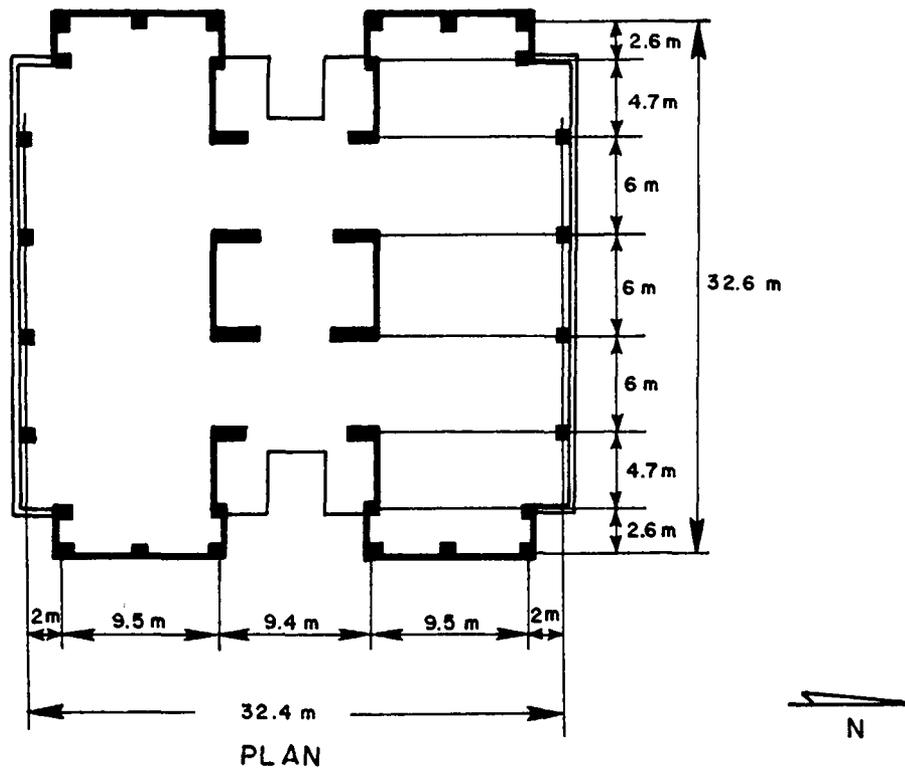
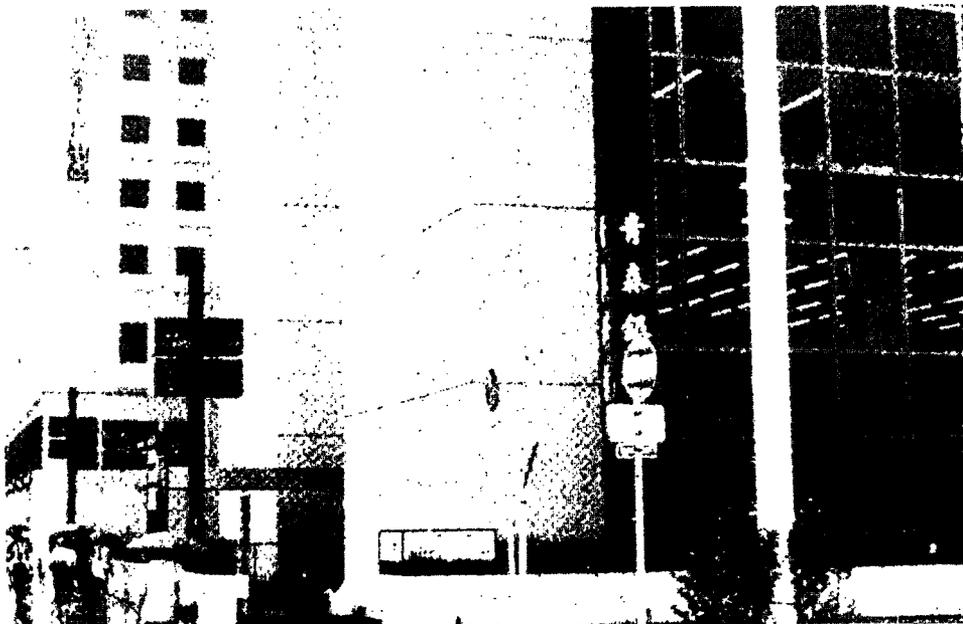


Figure 5.15 Sumitomo Insurance Building, Sendai, plan view. The building has continuous shear walls around the elevator core and on the transverse outside walls.

Figure 5.16 Sumitomo Insurance Building.
Exterior Elevation



Figure 5.17 Sumitomo Insurance Building.
Detail of exterior shear wall.



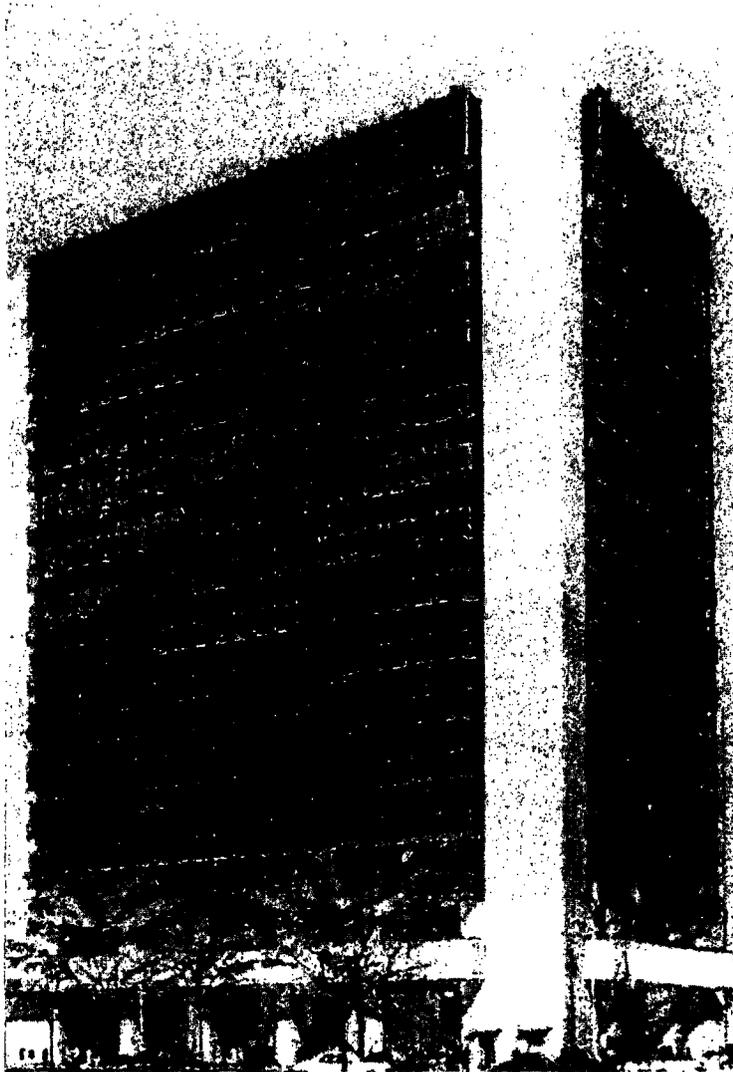


Figure 5.18 77 Bank Building,
Sendai. Exterior
elevation. (company
photograph).

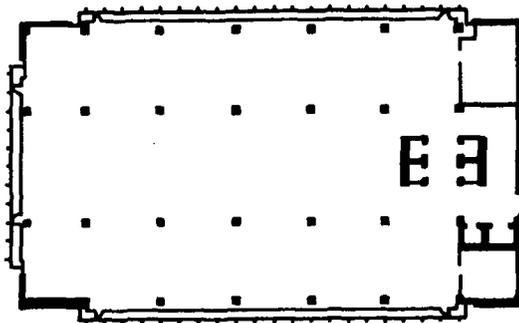


Figure 5.19 77 Bank Building.
Typical floor plan.

In this general area, referred to as Oroshicho, numerous buildings suffered extensive damage and there were several reinforced concrete structures which collapsed. The latter were all in the two to four-story range. Most of the buildings in this area were reported to be built on pile foundations, although no particulars for specific buildings were obtained. The collapsed reinforced concrete structures were all designed and built in the middle 1960's prior to the adoption of the 1971 seismic building code.

There were no acceleration records obtained in this area. However, shaking in the N-S direction apparently was stronger than in the E-W direction, at least in the area visited, since most of the damage observed to buildings resulted from strong motion in the N-S direction.

There was extensive evidence of ground settlement in the Oroshicho area, including settlement of asphaltic concrete sidewalks and slumping around building foundation walls, as in Figures 5.20, and 5.21.

Maruyoshi Building (No. 6, Figure 5.3). This was a three-story reinforced concrete frame building, one span by three, with the long axis of the building running in the E-W direction. There was a 2 m overhang on the north side of the structure (Figure 5.22). The wall shown at the west end was continuous from the second-story on up. The building had a flexible first-story. The building suffered extensive damage to the first-story (Figure 5.23) and, as shown in Figure 5.24 was tilting toward the north. The first story columns on the south side of the building failed in shear due to the strong N-S motion. A detail of the beam-column joint where the second-story floor beam frames into the first-story column is shown in Figure 5.25. Column ties appeared to be spaced at about 300 mm. The shear wall on the west end of the structure appeared to be undamaged. Unfortunately, this caused the structure to behave as an inverted pendulum and caused the first-story columns to accept even more shear. Note the use of the undeformed bars in the beam-column joint (Figure 5.25).

The building was being demolished at the time it was visited.

Obisan Building (No. 7, Figure 5.3). This was a three-story reinforced concrete frame building with one span in each direction (Figure 5.26). The portion of the building which overhung the column line by about 2 m contained a heavy stairwell. There were no openings in the overhanging part of the building, which added to the eccentric mass. Coupled with the strong N-S motion, this caused a failure in torsion as the columns at the west end of the building were unable to withstand the forces resulting from the large eccentric mass. Figures 5.27 and 5.28 show the Obisan Building after the earthquake viewed from the north and south, respectively. It may be observed that the upper stories rotated almost as a rigid body when the first floor columns failed. The first-story of the building had been used as a display area, and was completely open. A detail of the SE column is shown in Figure 5.29 and in the plan. As shown in Figure 5.30, the first floor support beams were practically resting on the ground at the west end of the building. The walls above the first-story suffered extensive cracking during the earthquake, but remained intact (Figure 5.31). The reinforcing bars that can be seen are undeformed.

Kinoshita Building (No. 8, Figure 5.3). This three-story reinforced concrete frame building, two spans by six, had its main axis in the N-S direction. As shown in Figure 5.32, there was extensive diagonal cracking on the east face. The first floor on the west side of the building, Figure 5.33, was used as a showroom. Unlike the backside of the building, where the columns were stiffened by spandrels, the columns on the west side were relatively flexible, and there appeared to be very little damage on that side of the building. The brick facing on the west side remained intact. The interior columns on the east side of the building showed large shear cracks and buckling of exposed undeformed bars. A reinforced masonry partition wall also failed here. It is apparent that most of the seismic force was attracted to the relatively stiff east side of the building. In addition, there appeared to be significant settlement of about 100 - 150 mm in the interior of the building on the east side. This, along with the relative stiffness of the east face, would explain the diagonal cracking pattern observed on the east face as well as cracking patterns observed in columns and panels. Failures of this sort were also observed following the Niigata earthquake (Okamoto, 1973).

Maruhon Building (No. 9, Figure 5.3). This six-story reinforced concrete frame building is located one block west of the Kinoshita Building. There was a construction gap of approximately 30 mm between the two parts of the building and no evidence of pounding. There is



Figure 5.20 Oroshicho area, Sendai.
Ground settlement.

Figure 5.21 Oroshicho area. Sidewalk damage
caused by ground settlement.



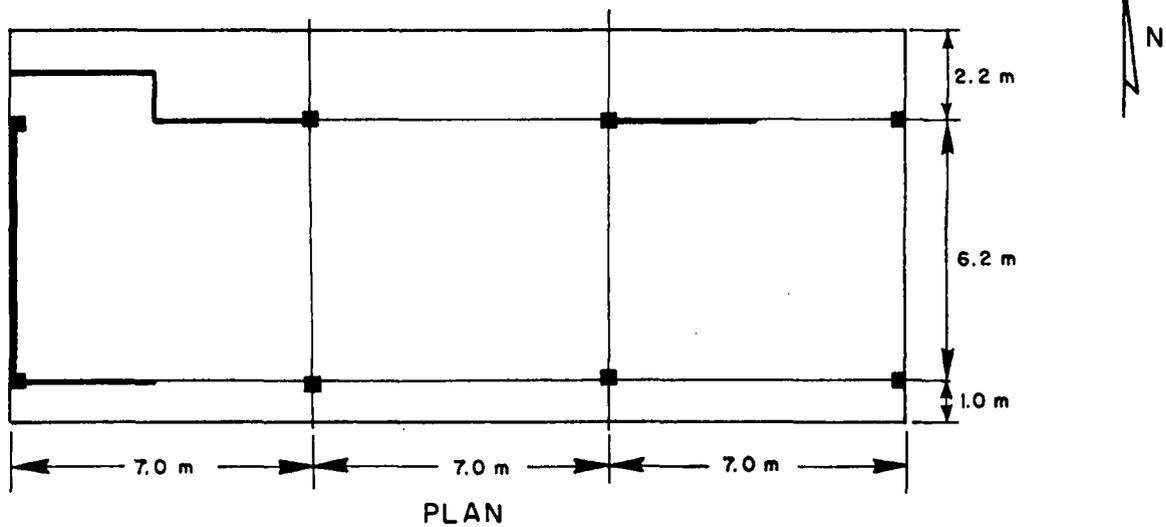


Figure 5.22 Plan view of Maruyoshi Building, Oroshicho area. Note overhang to the north.

Figure 5.23 Maruyoshi Building, view from the northwest. This three story reinforced concrete frame, one span by three, suffered almost total collapse of the first floor.

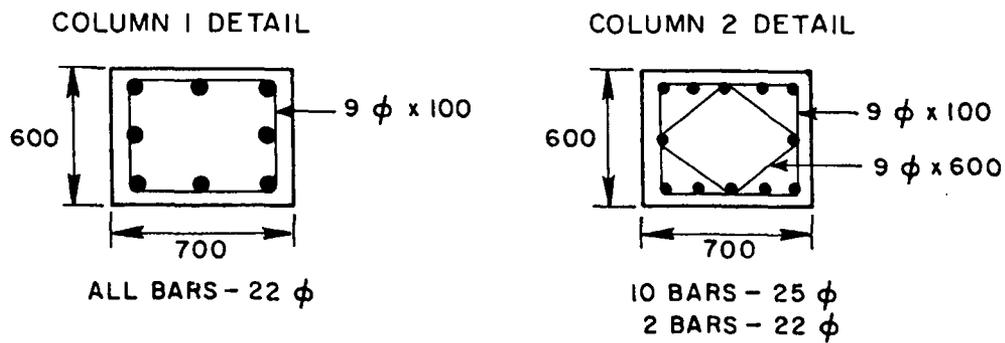
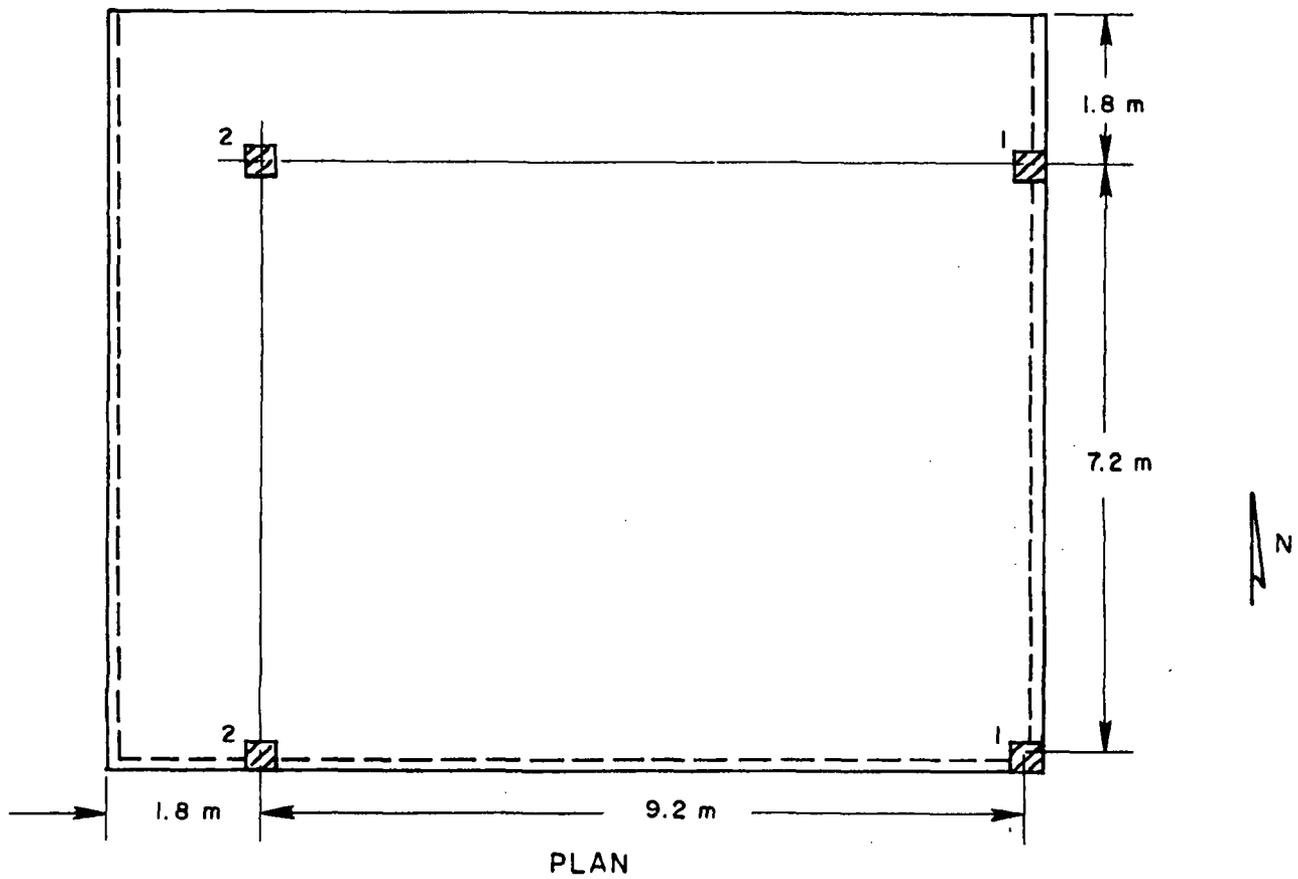




Figure 5.24 Maruyoshi Building, view from the east. Failure of first story columns occurred in shear.



Figure 5.25 Maruyoshi Building. Detail of a joint at the top of a first story column.



DETAILS (ALL DIMENSIONS IN MM)

Figure 5.26 Plan and column details of Obisan Building, Oroshicho area.

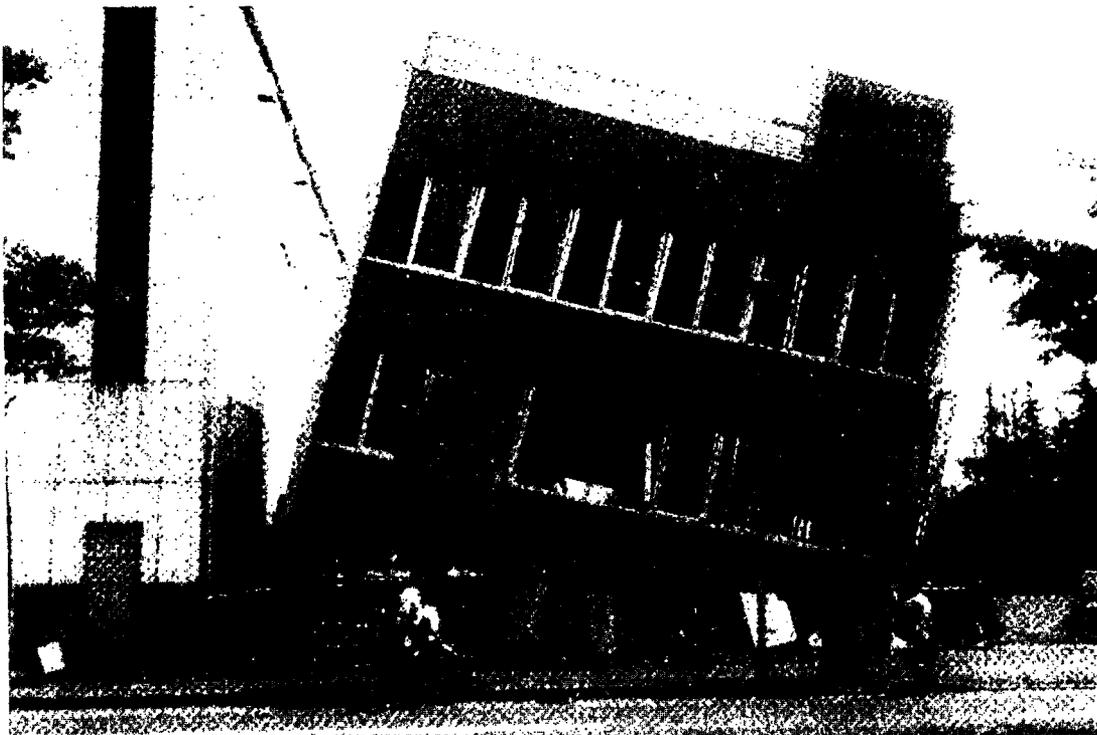


Figure 5.27 Obisan Building, viewed from the North. This three story reinforced concrete frame building had a heavy eccentric stairwell cantilevered over the column line at the right end of the building.

Figure 5.28 Obisan Building, viewed from the south. The upper stories rotated as a rigid body when the first floor column support was lost.

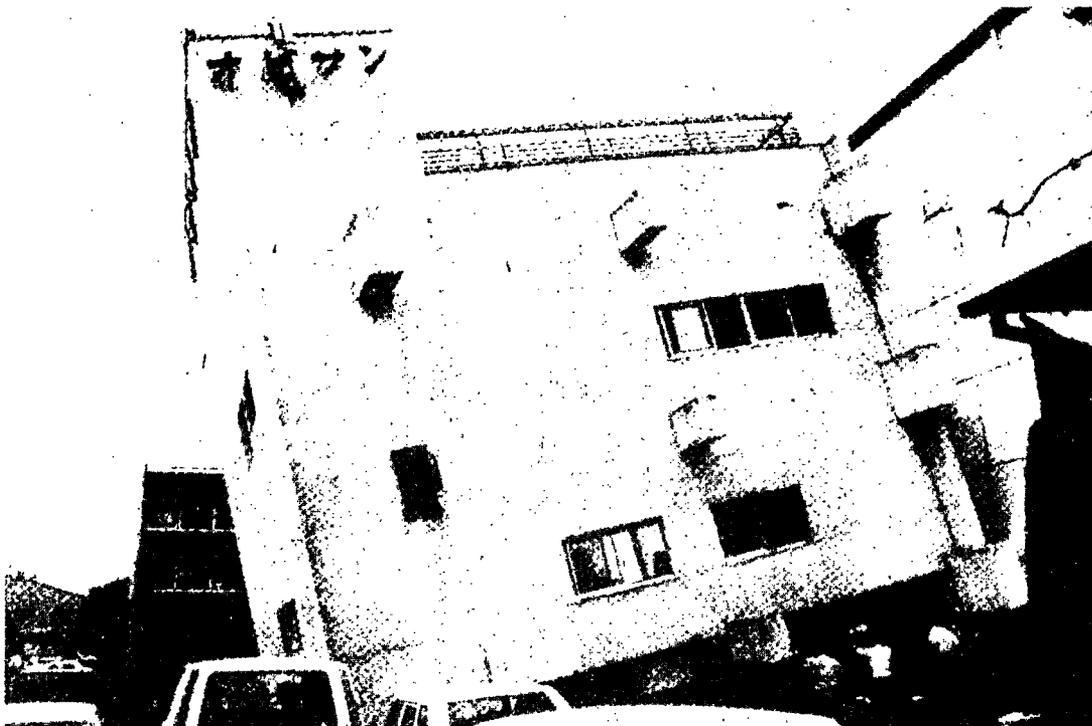




Figure 5.29 Obisan Building, detail of southeast column.



Figure 5.30 Obisan Building, detail of southwest column adjacent to overhang.



Figure 5.31 Obisan Building, south face. Walls above first story remained essentially intact.

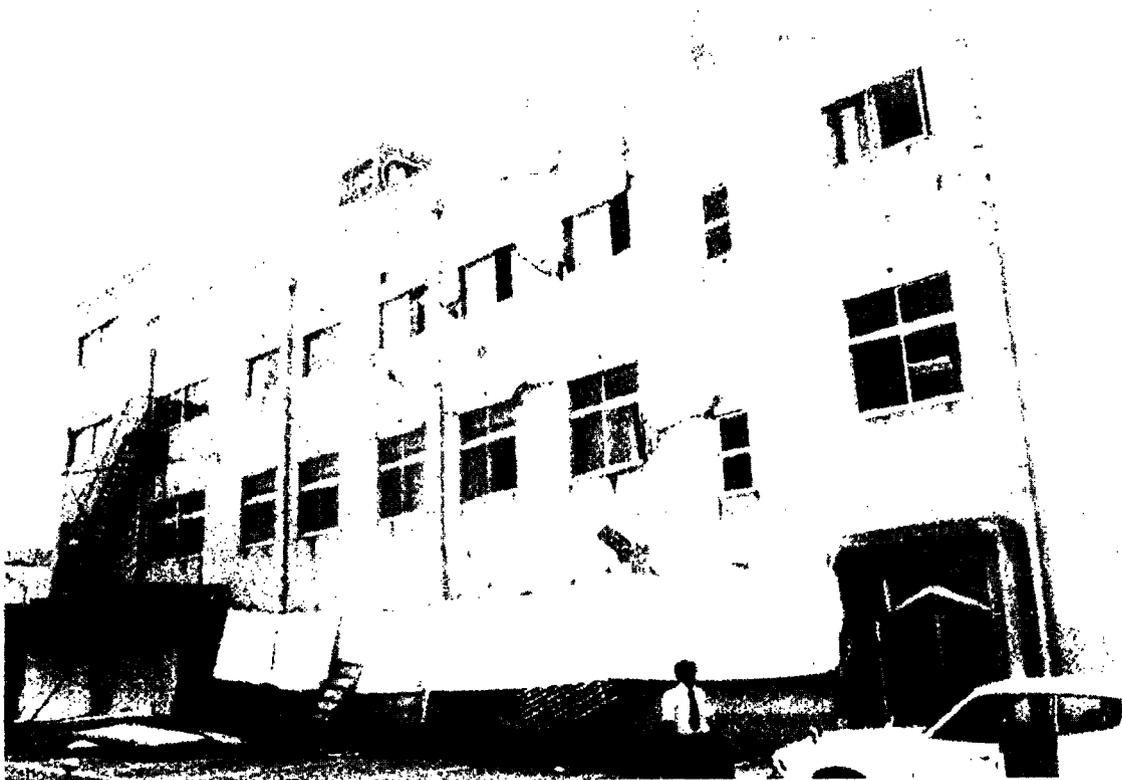
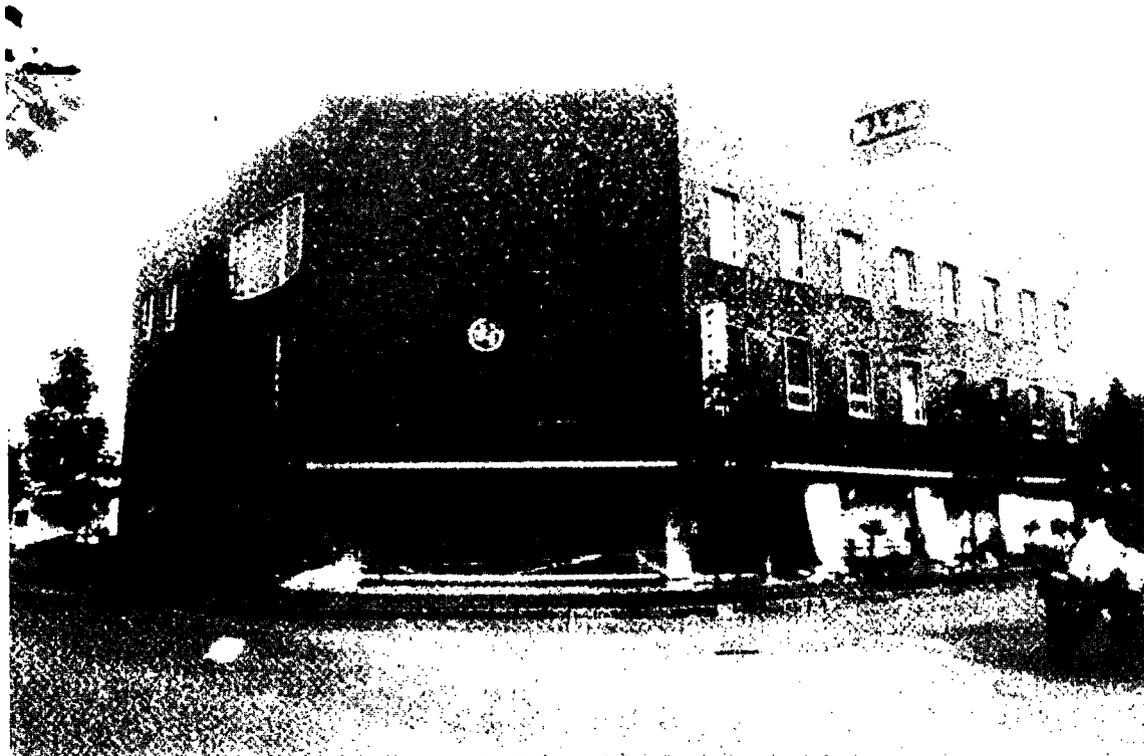


Figure 5.32 Kinoshita Building, Oroshicho area, of Sendai. Extensive diagonal cracking was observed on the east face (rear) of the building.

Figure 5.33 Kinoshita Building. The brick facing on the west side of the structure showed little sign of damage.



extensive diagonal cracking in the panels between window openings on both east (Figure 5.34) and west faces (Figure 5.35); this damage is especially severe on the west face, as shown in the detail in Figure 5.36. The decorative ceramic brick facing on the north side of the building did not appear to be damaged.

Despite the level of damage in the Oroshicho area, many buildings performed quite well. As an example, Figure 5.37 illustrates a 9-story building which was only slightly damaged. No details about its construction are known.

Yazaki Industries (No. 10, Figure 5.3). Figure 5.38 shows portions of the three Yazaki buildings. The building on the left has a steel frame with diagonal bracing used as a warehouse. The middle building (tilted) has a four story reinforced concrete frame, 3 spans by 5, which was used as an office building. It was built around 1970. The design acceleration was 0.2 g. The two-story building on the right, a steel frame completed in 1973, was used as a showroom. The buildings are aligned in the N-S direction.

The strong N-S component of the earthquake caused shear failures in the first story concrete columns in the middle building and a collapse at the ground story, causing the entire building to tilt north. This racked the two-story steel frame building forward, causing extensive damage to the steel frame and popping glass panes from showroom windows. The area of impact between the two buildings is shown in Figures 5.39 and 5.40 and 5.41. Figure 5.42 shows a detail of the beam-column joint at the top of the first-story column on the east side of the middle building. The column shear failure extended up into the beam. A detail of the column on the northeast corner of the middle building in Figure 5.43 shows the gross vertical displacement and badly distorted bars in the columns. Unlike the other collapsed buildings in the Oroshicho area, deformed reinforcing bars were used in the Yazaki building. The building service systems between the two impacted buildings were damaged.

The steel frame warehouse behind the collapsed building (Figure 5.38) did not appear to be damaged. The warehouse contained numerous heavy tubular steel frame storage racks with diagonal braces, as shown in Figure 5.44. The storage racks stand approximately 7 m in height and are anchored to the concrete floor by being bolted or welded to steel plates in the floor. Although none of the racks had collapsed, the bottom diagonal braces appeared to have buckled on several racks, as shown in Figure 5.45.

On an adjacent site to the south of the warehouse, there are two five-story reinforced concrete frame apartment buildings with shear walls oriented in the N-S direction. There was no apparent damage to either of these buildings, one of which is shown in Figure 5.46.

Paloma Building (No. 12, Figure 5.3). This reinforced concrete frame structure faced north and was located on Japan National Highway 45. It was a three-story rectangular building, two spans by three, with a shear wall on the west end of the building. The first floor was used for display, and had a large open area on the north and east side of the first floor. The main axis of the building ran in the E-W direction. Figures 5.4 and 5.48 show the Paloma Building viewed from the east following the earthquake. Failure occurred in the columns at this end of the building, causing the building to tilt toward the east. However, the shear wall at the west end of the building was also badly damaged (Figures 5.49 and 5.50). It is likely that the eccentricity caused by the presence of the shear wall on only one end of the building caused a torsional mode of failure for the structure.

The exposed reinforcing bars in the columns were undeformed. The columns at the east end measured 500 mm by 500 mm. The column ties were 9 mm in diameter and were spaced at 300 mm, at least where the reinforcing was exposed. There was less than 25 mm concrete cover for the reinforcing bars in many instances. We were informed that this building was completed in 1963, making it one of the oldest buildings investigated.

Taiyo Fisheries Plant (No. 11, Figure 5.3). This was a three-story building with a reinforced concrete frame, one span by five, the main axis of which was in the N-S direction. There were shear walls on the north and south ends of the structure. As shown in Figures 5.51 and 5.52, the first-story columns in the middle of the building failed, causing the central portion of the building to collapse but leaving the ends standing. The shear walls at the north end of the structure (running in the E-W direction) were badly cracked. At the time the site was visited, the building was being demolished.



Figure 5.34 Maruhon Building, Oroshicho area, showing shear cracking in the panels on the east face between window openings.

Figure 5.35 Maruhon Building, west face, showing cracking of curtain wall panels.





Figure 5.36 Maruhon Building, west face. Detail of the damage to panels between windows.

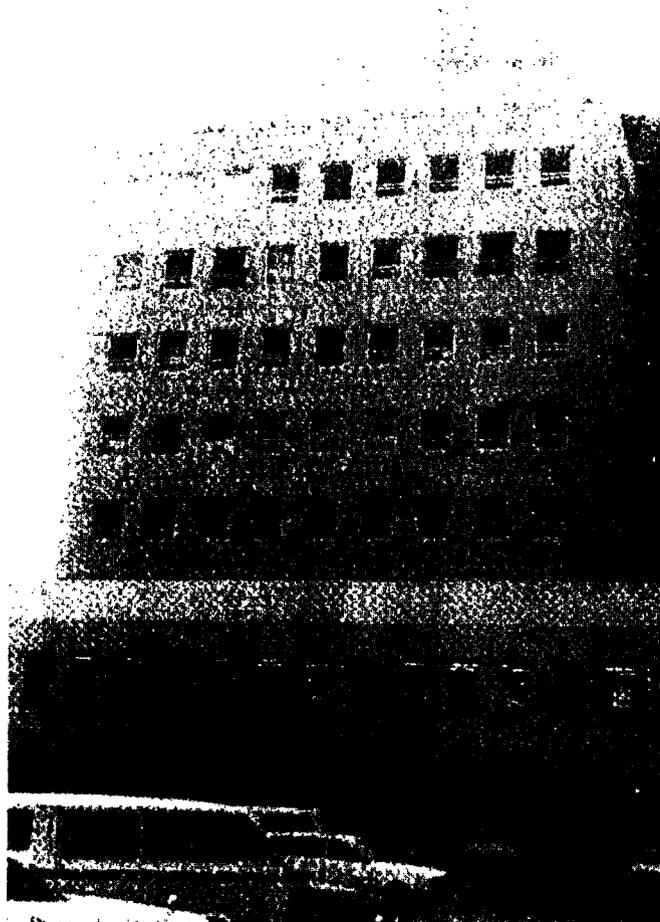


Figure 5.37 A slightly damaged 9 story building in the Oroshicho area of Sendai.



Figure 5.38 Yazaki Industries Buildings, viewed from the northeast, Oroshicho area. Portions of three Yazaki buildings are shown. Failure of the reinforced concrete middle building caused it to rack forward against the front steel structure.

Figure 5.39 Yazaki Industries Building, viewed from the east.





Figure 5.40 Yazaki Industries, showing area of impact between steel and reinforced concrete frames.



Figure 5.41 Yazaki Industries, showing damage to lower story reinforced concrete column.



Figure 5.42 Yazaki Industries Building, showing beam-column joint at top of first story column, east side.



Figure 5.43 Yazaki Industries Buildings. Detail of column shear failure, east side. Note use of deformed bars.



Figure 5.44 Yazaki Industries warehouse building. A number of multi-level tubular steel storage racks had damaged transverse braces at ground level.

Figure 5.45 Yazaki Industries warehouse. Detail of diagonal brace at bottom of storage rack.





Figure 5.46 Apartment building adjacent to Yazaki Industries warehouse building to the south. The building was undamaged.

Figure 5.47 Paloma Building - Viewed from the east. Collapse occurred at the east end of the building.





Figure 5.48 Paloma Building. - Detail of first story, east end, showing inferior quality concrete.



Figure 5.49 Paloma Building,
west face.

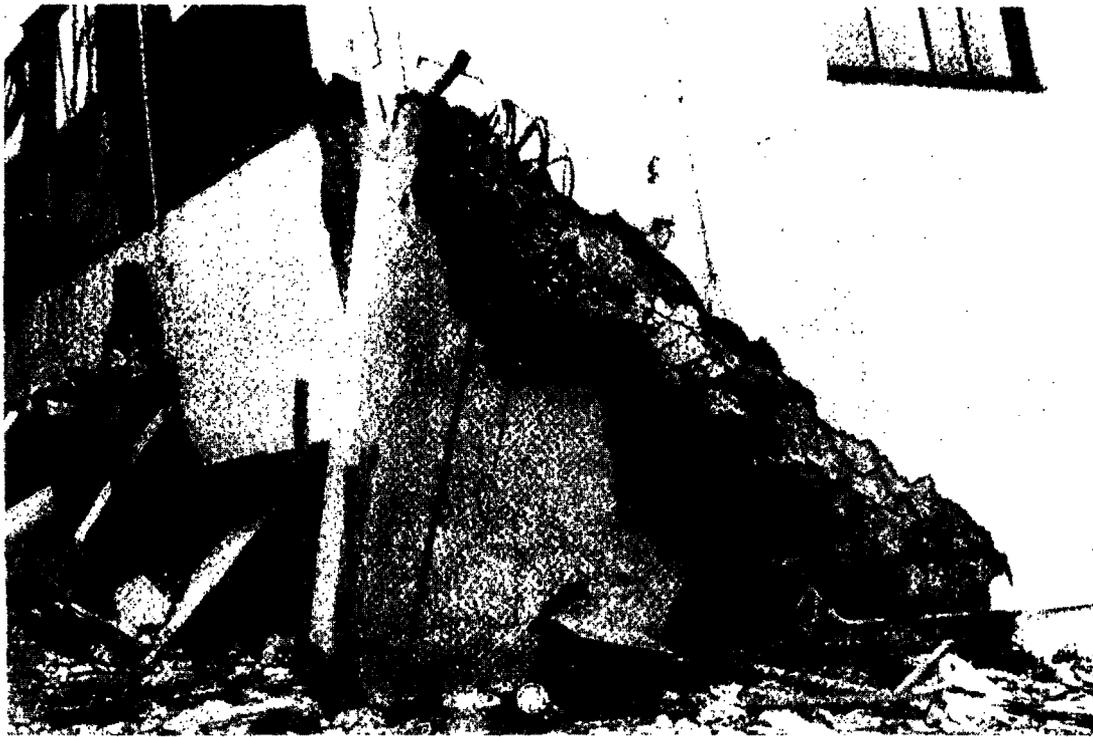


Figure 5.50 Paloma Building, detail of shear wall on west end of building.

Figure 5.51 Taiyo Fisheries Plant, viewed from the west. The first story columns in the center portion of the building failed, leaving the ends of the building standing. (Japan National Land Agency photograph)





Figure 5.52 Taiyo Fisheries Plant, viewed from the northeast. The reinforced concrete shear wall on the north end was badly damaged.

5.4 Schools

Four schools and university campuses were visited: (1) Tonan High School (two buildings), (2) Izumi Prefectural High School (four buildings), (3) Tohoku University, and (4) Tohoku Institute of Technology (two buildings). As may be seen from the map in Figure 5.3, these facilities are spread out over the Sendai metropolitan area, and they represent only a small percentage of the total number of school buildings.

Tonan High School (No. 13, Figure 5.3). This was a three-story reinforced concrete frame building oriented in the N-S direction with shear walls in the E-W direction. The school was built about 12 years ago using the pre-1971 code.

The school is located on the east side of the city where the soil conditions are relatively poor. The east side of the building sits on a small bluff approximately 6 m in height. This may have amplified the ground motion at the site. The school was badly damaged by the earthquake and has been closed.

The west face elevation and the school yard are shown in Figures 5.53 and 5.54. The exterior first-story columns were all severely damaged, the shear cracks occurring just above the infill panels, (Figures 5.55 and 5.56). In many cases the width of the cracks was over 20 mm. The upper story columns showed less shear cracking. The interior columns did not appear to be damaged. They lacked the stiffening provided by the infill panels. A corridor ran along the length of the building in the middle, and the shear walls were not continuous across the width of the building. Undeformed reinforcing bars were used in the columns. The ties in the exterior columns were spaced at roughly one-half the maximum dimension of the column.

Much of the damage at Tonan High School may be attributed to the unfavorable orientation of the shear walls with respect to the direction of strongest shaking (N-S). A building adjacent to the school but oriented perpendicular to it, which was constructed about the same time and in which the shear walls run in the N-S direction, was undamaged, aside from a few broken windows.

Izumi High School (No. 21, Figure 5.3). The school campus is located in the suburb north of Sendai, approximately 2 km from the Tohoku Electric Power Company Substation, which is discussed in Chapter 7. The buildings were completed in 1973, and their design was based on the 1971 building code. The school was occupied at the time of our visit. Several other schools in the same general area, also designed according to the new standard, suffered less damage than Izumi High School. We were informed that relative to Tonan High School, the soil conditions at the Izumi site were better.

The building plan in Figure 5.57 shows three interconnected classroom buildings, and a steel frame assembly hall (auditorium or gymnasium). The steel frame building appeared to be only lightly damaged from the outside. The classroom buildings are three-story reinforced concrete frame structures with transverse shear walls (not shown, but coinciding with the end classroom walls and stairwells). Classroom corridors extend along the north side of each building.

Figure 5.58 shows the east elevation of the three classroom buildings, and Figure 5.59 shows the front entrance on the north side of building 1. The badly cracked panel above the entrance is not connected to the ground floor. The interior corridor walls in the building had extensive diagonal cracks, as shown in Figure 5.60. Figure 5.61 shows the northeast corner of building 2 along the foundation. The diagonal crack at the corner of the exterior wall indicates that either uplifting or settlement of the foundation took place. Figures 5.62 and 5.63 show typical damage on the north and south sides of one of the classroom buildings. Damage was relatively greater on the north side of the building where the columns were stiffened by the infill panels. Although there were numerous diagonal cracks emanating from window openings on the north side, the main columns did not appear to be badly cracked.

Note from Figure 5.57 that the interior shear walls do not run the width of the building, as they are interrupted by the corridor on the north side of the building. The cracking was less severe on the open side of the building, where the shear walls connect to the columns.

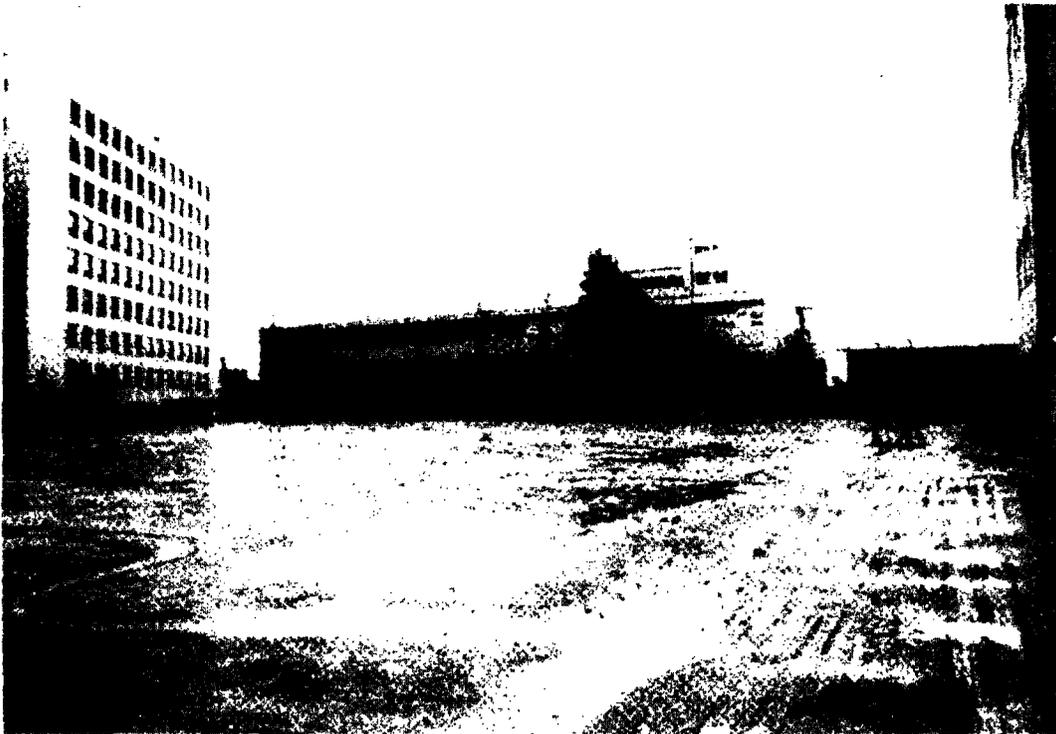


Figure 5.53 Tonan High School, west face. A small bluff on the opposite side of the building may have amplified ground motion. The adjacent structures were undamaged.

Figure 5.54 Tonan High School - Detail of damage to west face.

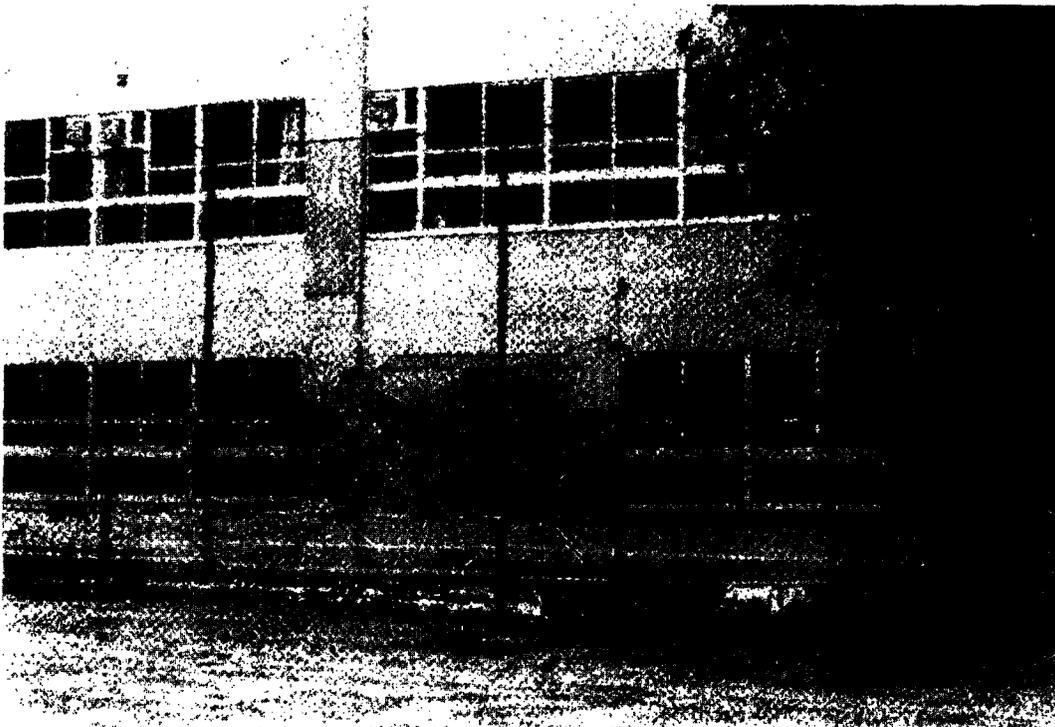




Figure 5.55 Tonan High School. Detail of shear cracking in exterior column above partial infill panels on east face

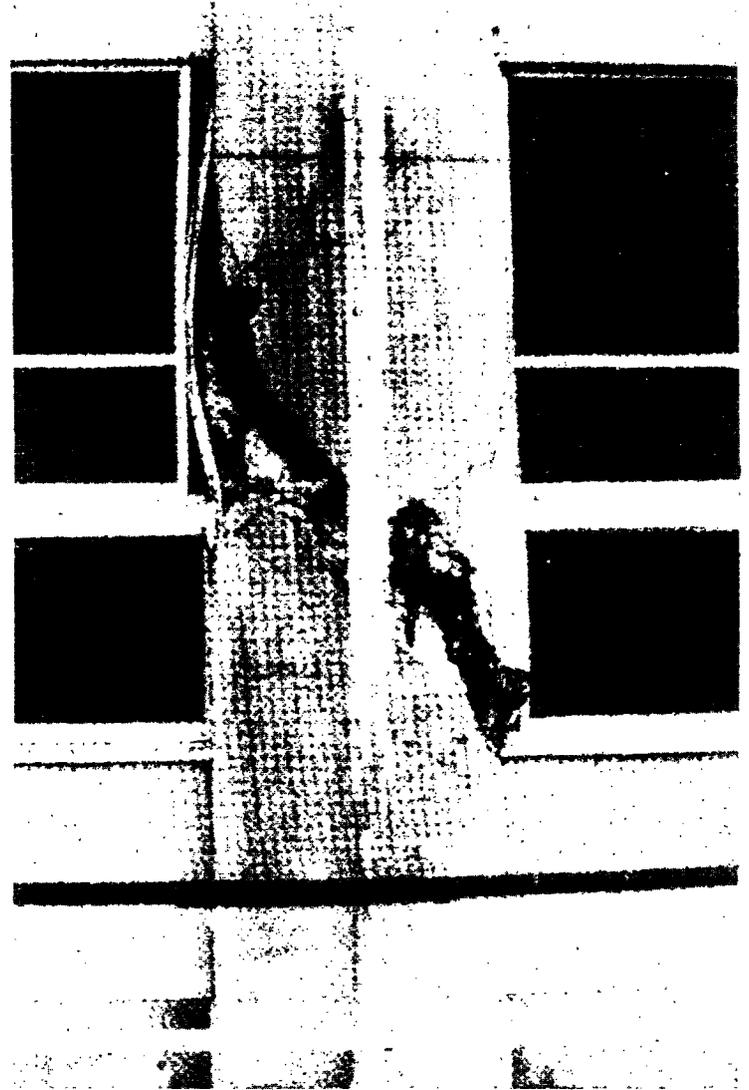


Figure 5.56 Tonan High School. Detail of column damage, exposing reinforcement.

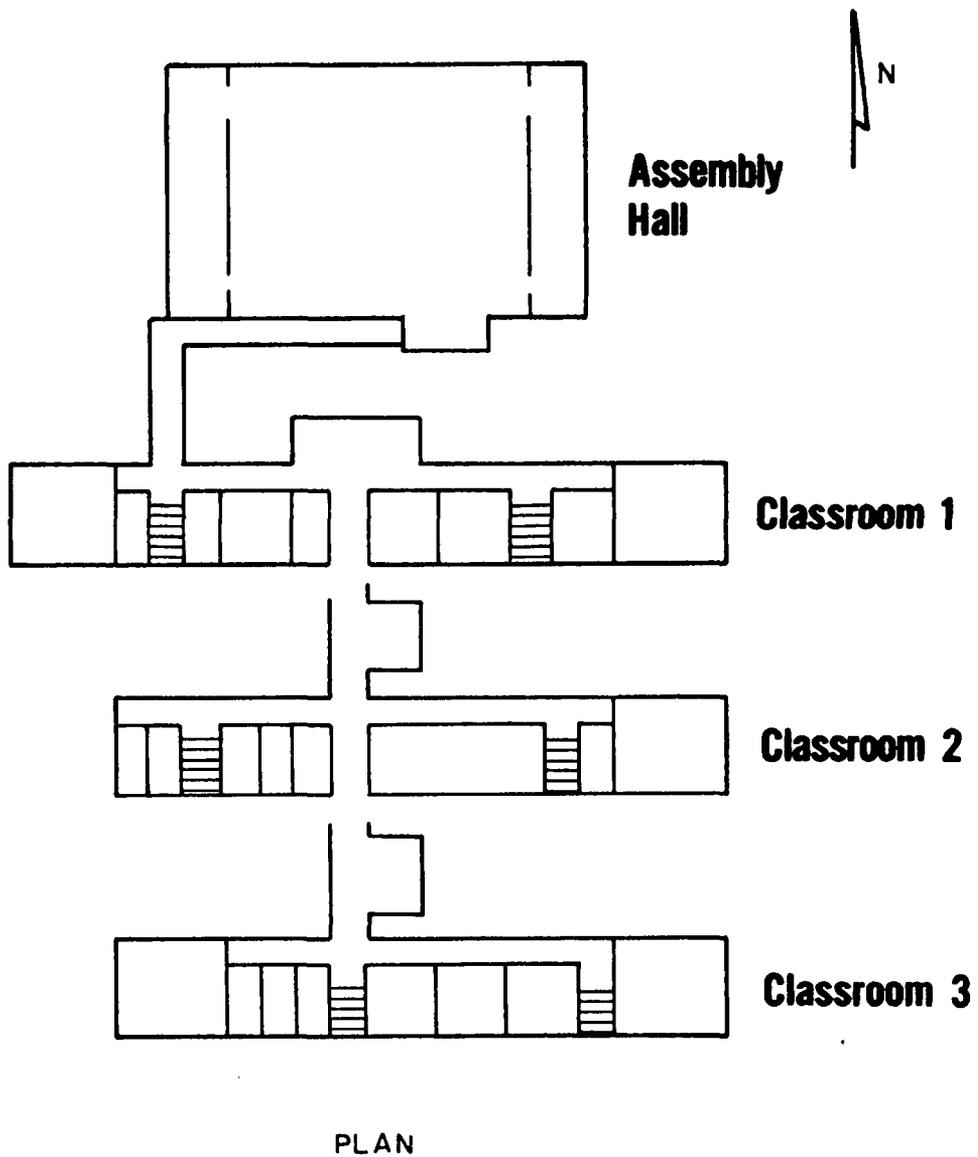


Figure 5.57 Izumi High School, Izumi City. Plan view of steel frame assembly hall and three reinforced concrete classroom buildings.



Figure 5.58 Izumi High School. Three adjacent reinforced concrete frame buildings with shearwalls suffered minor damage.

Figure 5.59 Izumi High School. Detail of panel over north entrance to building 1.



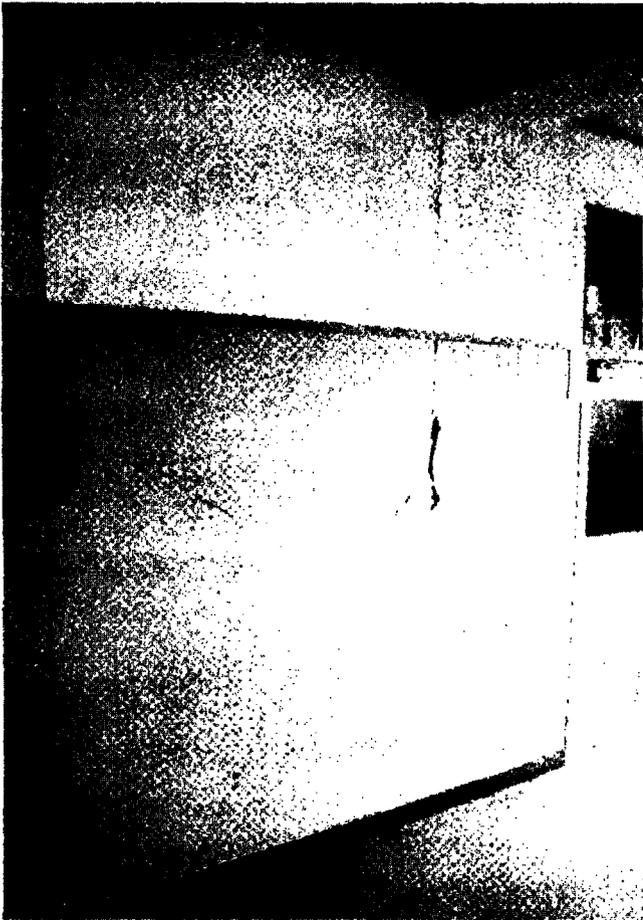
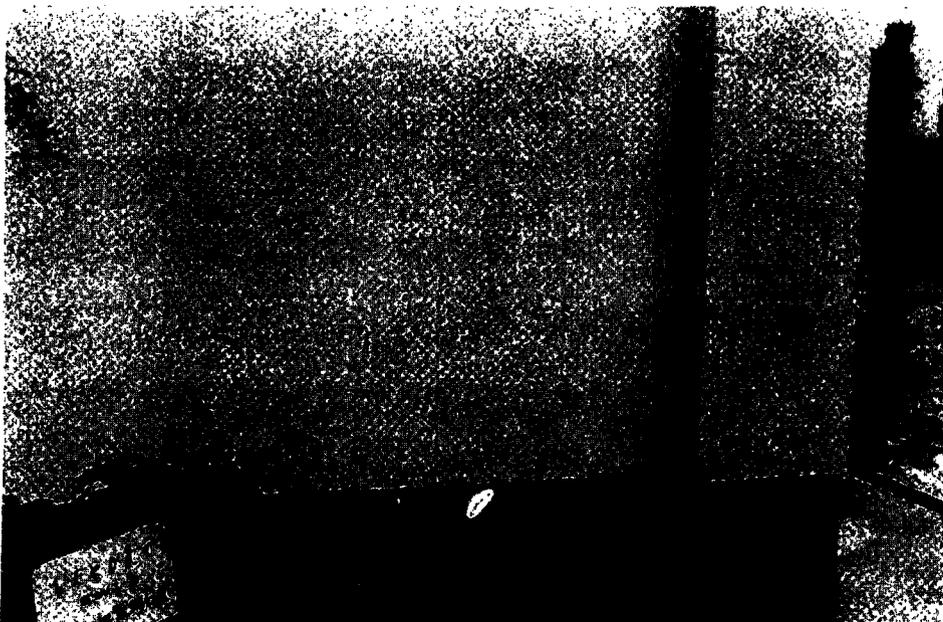


Figure 5.60 Izumi High School. An interior corridor wall in classroom building 1 aligned in the longitudinal direction of the building.

Figure 6.61 Izumi High School. The diagonal crack in the exterior wall shows that foundation settlement or uplift took place at the corner.



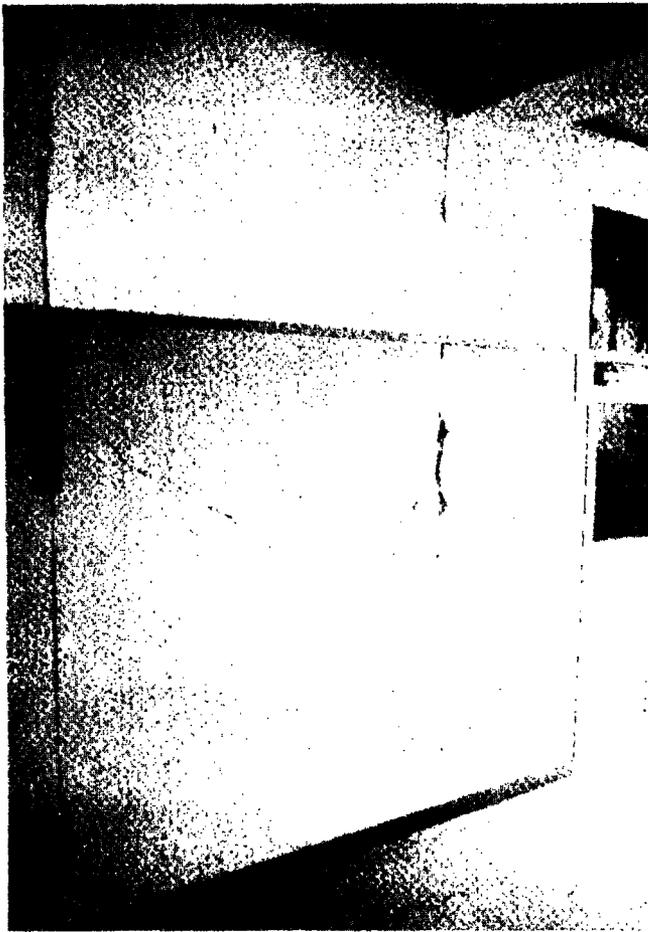
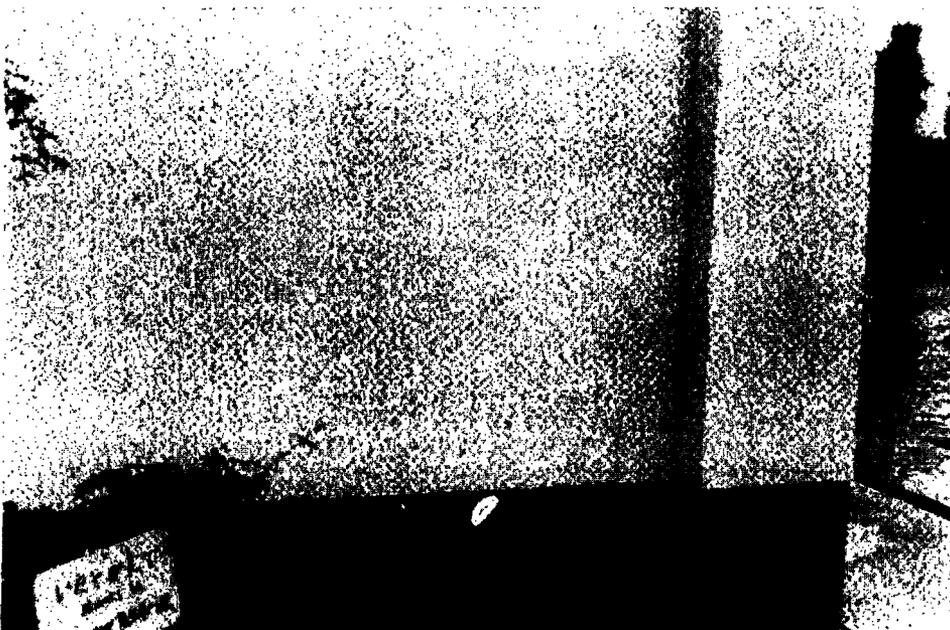


Figure 5.60 Izumi High School. An interior corridor wall in classroom building 1 aligned in the longitudinal direction of the building.

Figure 6.61 Izumi High School. The diagonal crack in the exterior wall shows that foundation settlement or uplift took place at the corner.



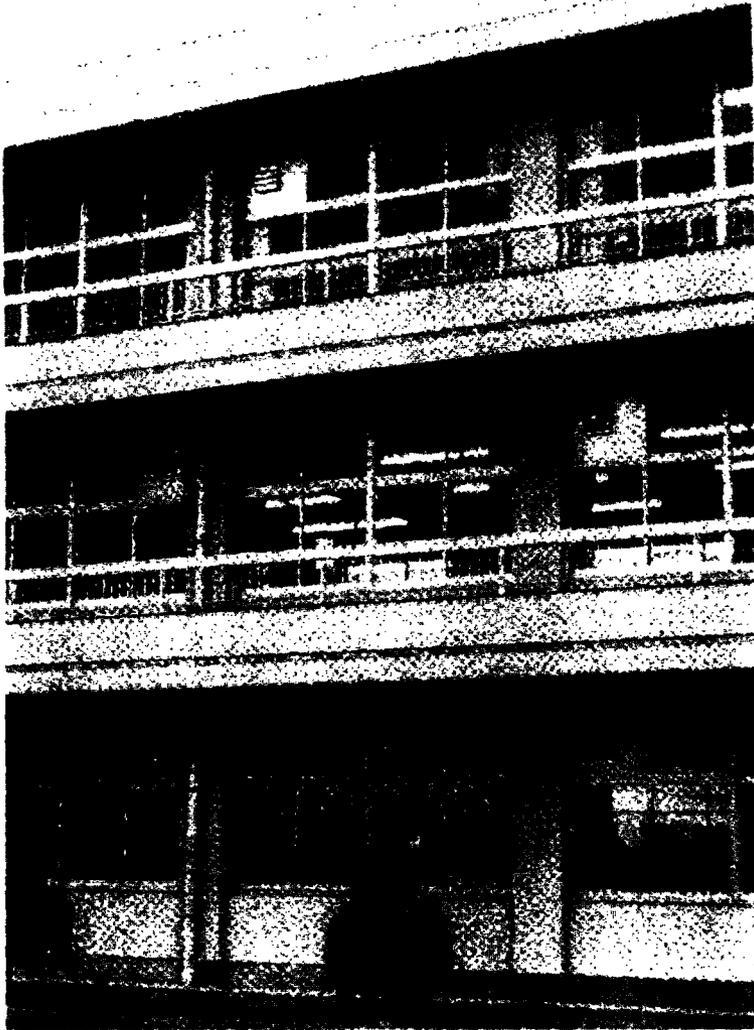


Figure 5.62 Izumi High School, typical classroom building, south face. This side of the building, which is relatively open, suffered little damage.

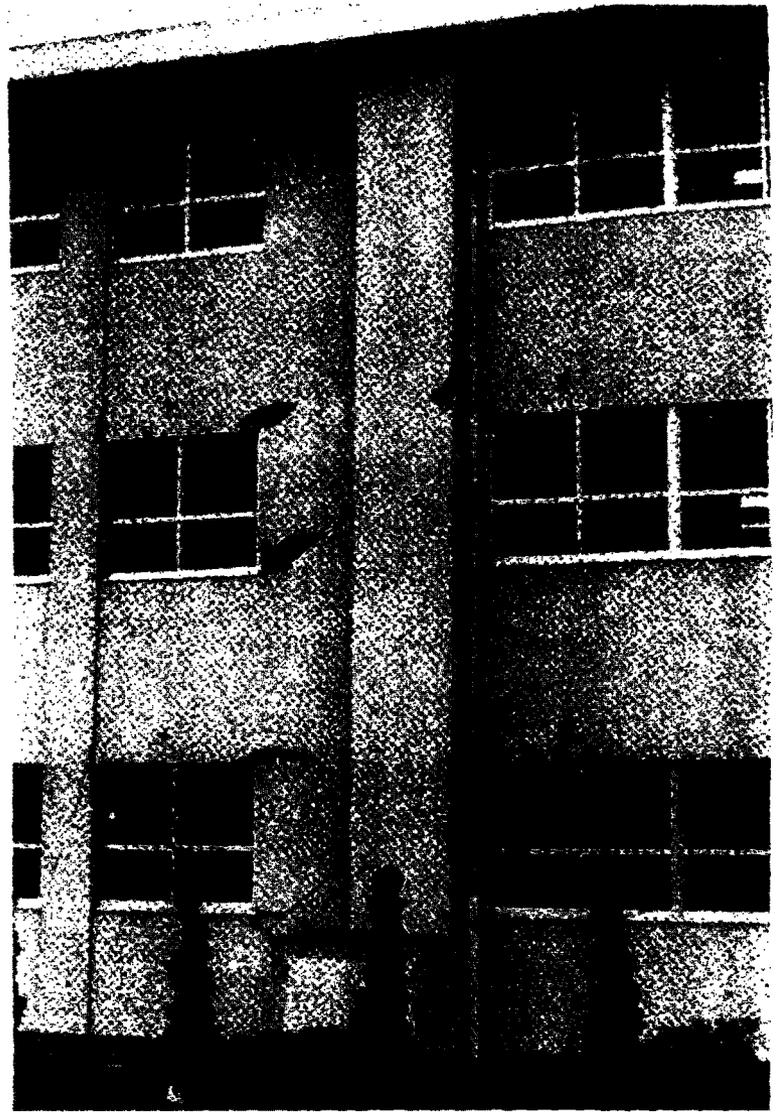


Figure 5.63 Izumi High School, typical classroom building, north face. All faces with the larger infill panels were similarly damaged.

Tohoku Institute of Technology (No. 17, Figure 5.3). The campus consists of several buildings located southwest of the downtown area of Sendai. The building layout is illustrated in Figure 5.64. The underlying soil conditions are reasonably good, being older terrace deposits. All buildings are situated on sand and have pile foundations. As may be observed from the contour map in Figure 3.12, this area of the city is quite hilly. Buildings No. 3 and 5 (labeled on Figure 5.64), constructed in 1965, were inspected in some detail. There were no strong motion instruments at the campus; however, ground accelerations at the site were estimated as 0.25g.

Figure 5.65 shows a partial view of the northeast facade on Building 5. Building 5 is situated on a steep hill running to the southwest and the northeast side entrance is actually located on the fourth-story of the eight-story reinforced concrete frame building. The upper five floors contain large classrooms and open spaces. Damage to building 5 was substantial, particularly on the northeast side. Light fixtures were shaken down and bookcases, wooden lecterns, and statues were overturned. Surprisingly, the elevator remained functional. Wall panels and floor diaphragms were cracked, (Figure 5.66). Such cracking was particularly noticeable near shear walls of the stairwell on the northeast side of Building 5.

The columns on the northeast side of building 5 were seriously damaged. Figure 5.67 and 5.68 show typical damage to exterior columns on the upper stories (stories 6 - 8). The infill panels stiffened the exterior columns on the northeast side of building 5. In contrast, the exterior columns on the southwest side and the interior columns had no such stiffening, were relatively flexible (Figure 5.69) and suffered no apparent damage. The lower story columns on the northeast side showed significant shear cracking and spalling, as illustrated in figure 5.70 for one exterior column on story four. Crack widths exceeded 10 mm in several instances. Visible column ties were spaced 250 mm apart and were wrapped around the corner longitudinal bars without hooks. Interior transverse shear walls also showed diagonal cracks. In at least one case where the transverse wall was connected to a column, the diagonal crack in the wall continued on into the column. The transverse walls were connected to the columns on the north side with the tie beams. Figure 5.71 shows one of these tie beams following the earthquake.

Adjacent to building 5 on the northwest is a three-story reinforced concrete frame building completed in 1972. Figures 5.72 and 5.73 show this building and its walkway connection to building 5. It was constructed according to the post-1971 building code. Although the building was not entered, an inspection of its exterior revealed no signs of damage.

The northeast facade of building 3 is shown in Figure 5.74. This is a four-story reinforced concrete frame building, ten spans by two. While the relatively flexible interior columns were undamaged, all of the exterior columns on the first-story cracked in shear just above the infill panels, as shown in Figure 5.75. Figure 5.76 illustrates this more clearly at one of the first-story columns on the northeast side of building 3. As can be seen, the reinforcement is undeformed. We were informed that core samples taken out of the spandrels showed no apparent damage to the concrete.

Around the entrance on the east side of building 3 and the southeast corner of its first-story, large areas of the tile facing and concrete underneath had spalled off, exposing the reinforcement (Figure 5.77). At this location, the vertical reinforcing bars were bent manually during construction in order to force them to conform to the building working drawings. The reinforcement appeared to have less than 10 mm concrete cover. The interior walls of building 3 showed extensive diagonal cracking (Figure 5.78). However the interior columns were apparently not damaged.

Figure 5.79 shows the area between walkway along the northeast side of building 5 (see also Figure 5.65). The backfill along the northeast side of building 5 has settled, causing damage to the stairs to the entrance of building 5 and adjacent retaining walls. Ground settlement also has caused the paving of the walkway to crack.

It was reported that building 3 will be demolished and building 5 will be repaired. Estimates of the costs of repair for these structures were unavailable.

Tohoku University Engineering and Architecture Building (No. 19, Figure 5.3). Tohoku University is located west of the downtown area. As may be observed from the contour map in Figure

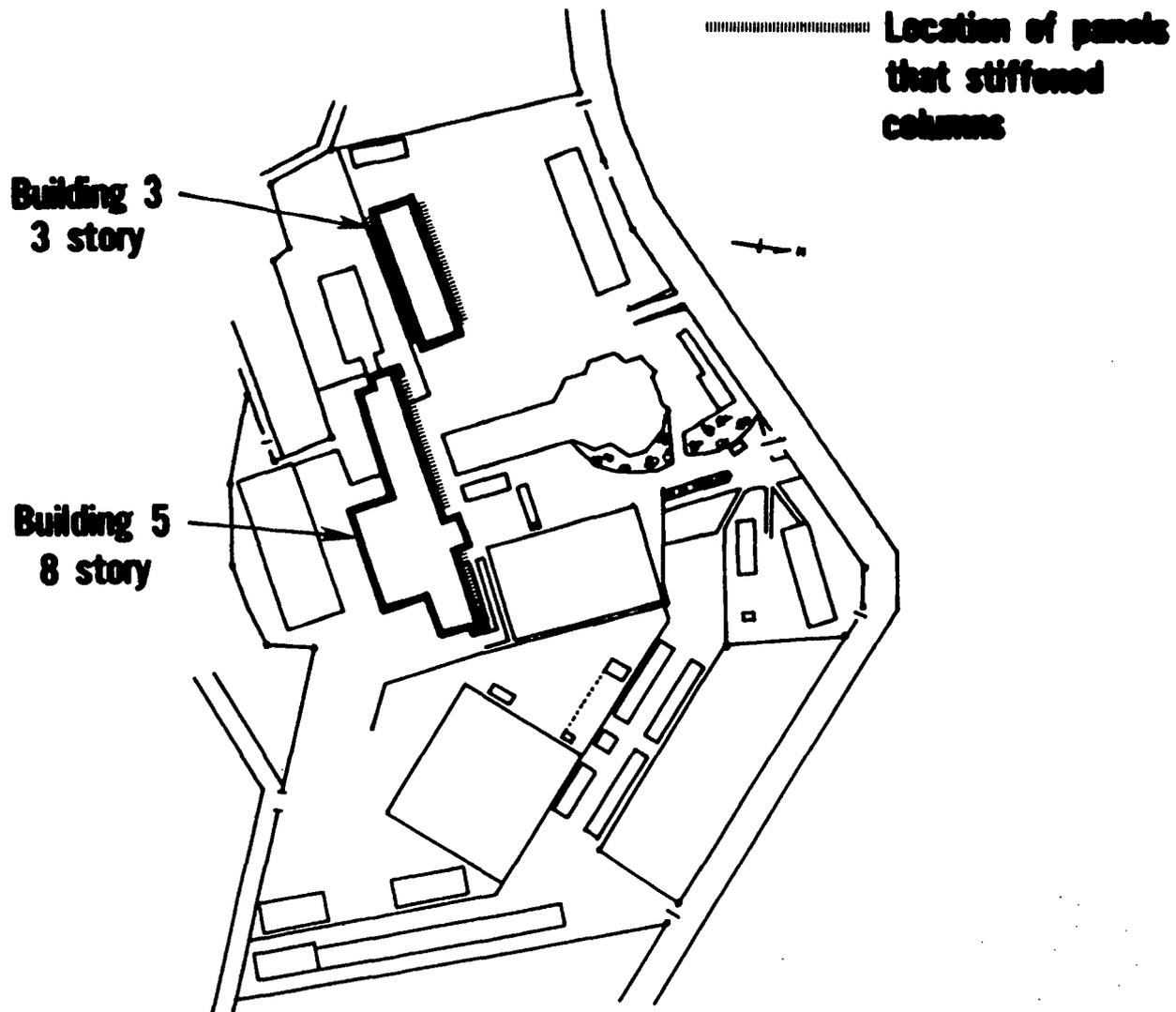


Figure 5.64 Tohoku Institute of Technology, Sendai, plan of campus. Hatching along walls of buildings 3 and 5 shows location of severely damaged columns.

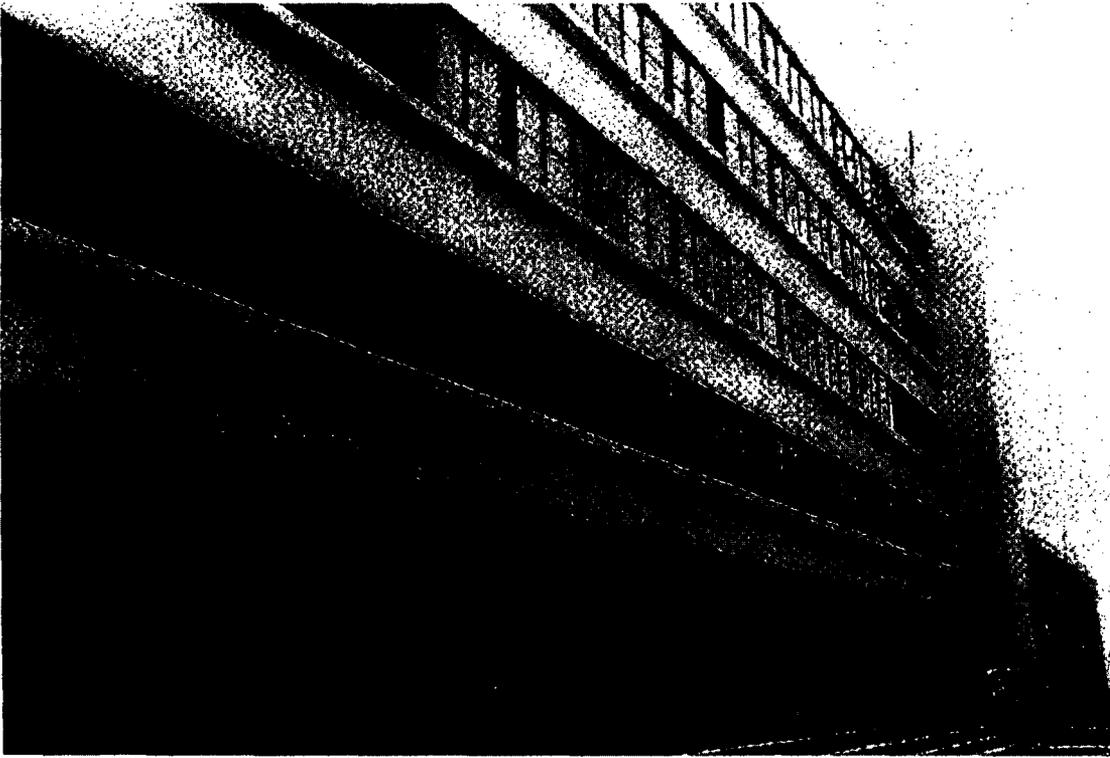


Figure 5.65 Tohoku Institute of Technology. Partial view of the entrance and north facade of building 5. Most serious damage to columns occurred on this side of the building.

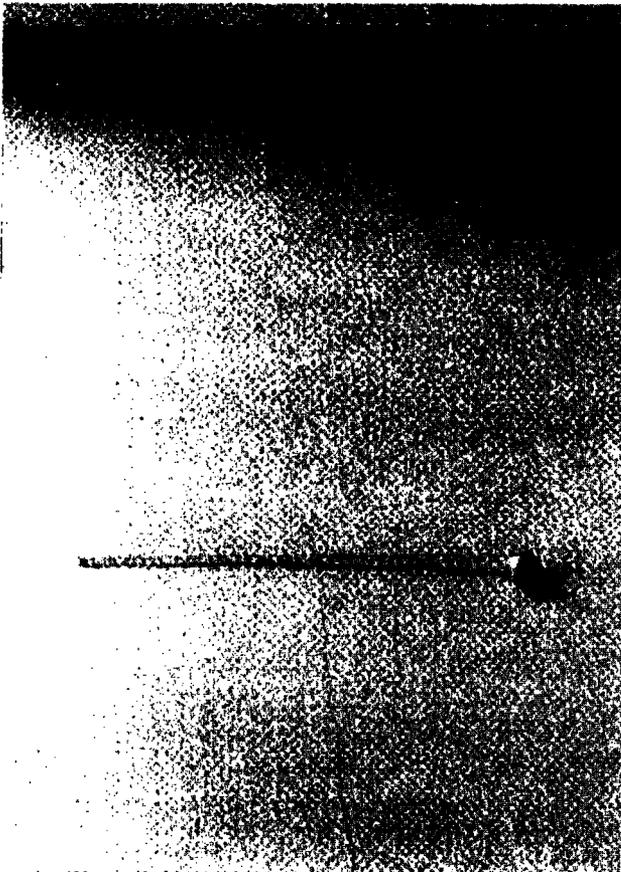


Figure 5.66 Tohoku Institute of Technology. Typical cracking of floor diaphragms at the sixth floor level, building 5.



Figure 5.67 Tohoku Institute of Technology. Typical damage to seventh story column of the north facade of building 5.



Figure 5.68 Tohoku Institute of Technology, Building 5. Detail of column damage.



Figure 5.69 Tohoku Institute of Technology, Building 5. Seventh story interior, looking towards the lightly damaged southern exterior frame.

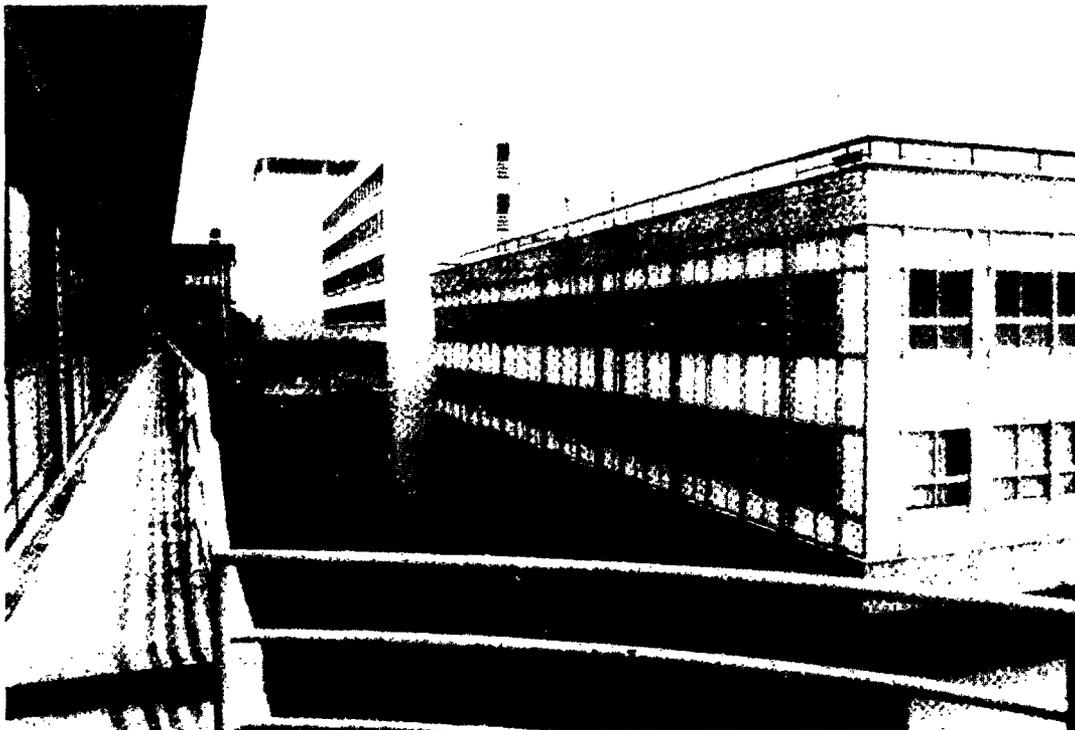


Figure 5.70 Tohoku Institute of Technology, Building 5. Damage to column on north side of third story. The tie spacing is 25 cm.



Figure 5.71 Tohoku Institute of Technology, Building 5. The tie beam over a sixth floor corridor connecting two shear walls shows diagonal cracks at both ends.

Figure 5.72 Tohoku Institute of Technology, concrete frame structure adjacent to building 5 on the west, completed in 1972.



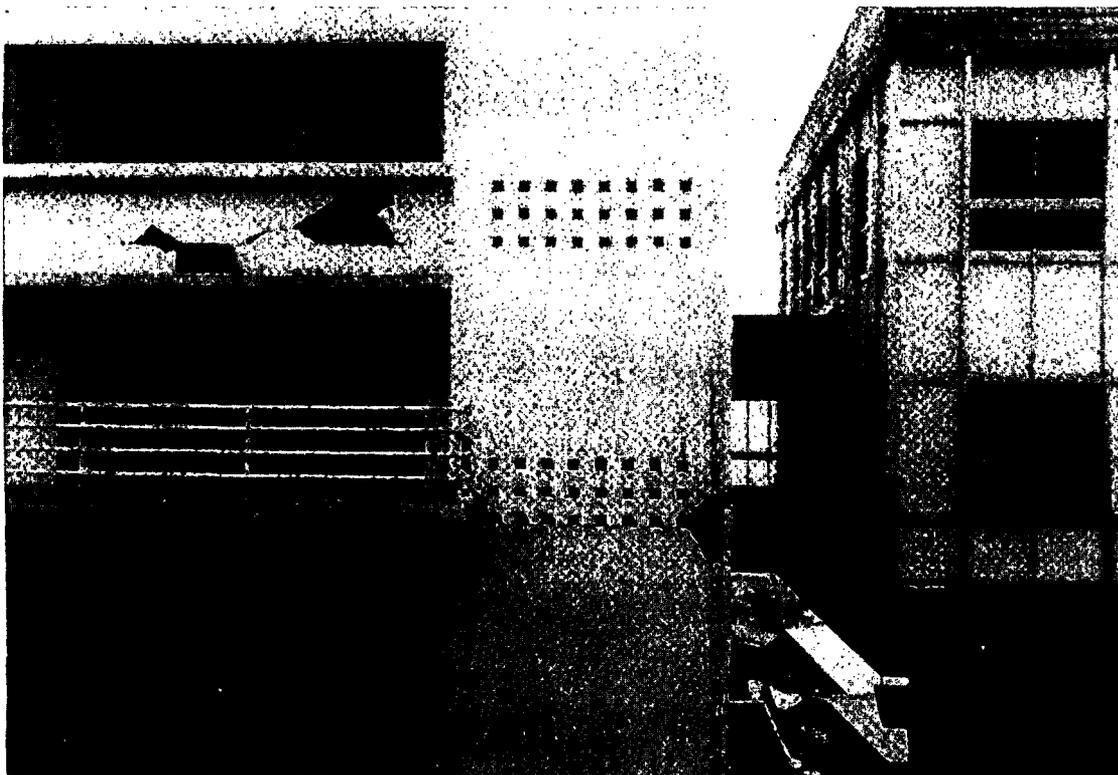


Figure 5.73 Tohoku Institute of Technology. Passage between Building 5 and the building to its west.

Figure 5.74 Tohoku Institute of Technology, Building 3. General view of the north elevation.





Figure 5.75 Tohoku Institute of Technology, Building 3. Damage to the ground floor columns on the south side of the building. Similar damage is present on the opposite side of the building.



Figure 5.76 Tohoku Institute of Technology, Building 3. Typical damage to ground story exterior column on north side of building.



Figure 5.77 Tohoku Institute of Technology, Building 3. Detail of one of the damaged columns of the exterior frame on the south side of the building showing reinforcing details.

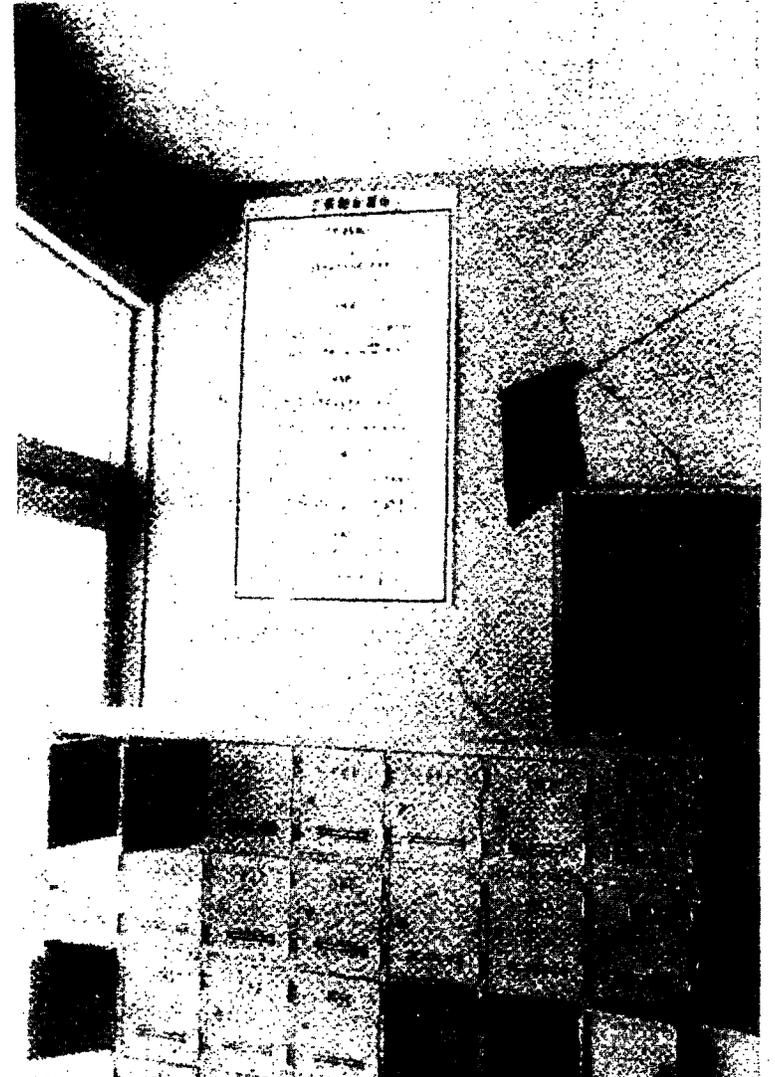


Figure 5.78 Tohoku Institute of Technology, Building 3. Interior surface of shear wall at east end of building.

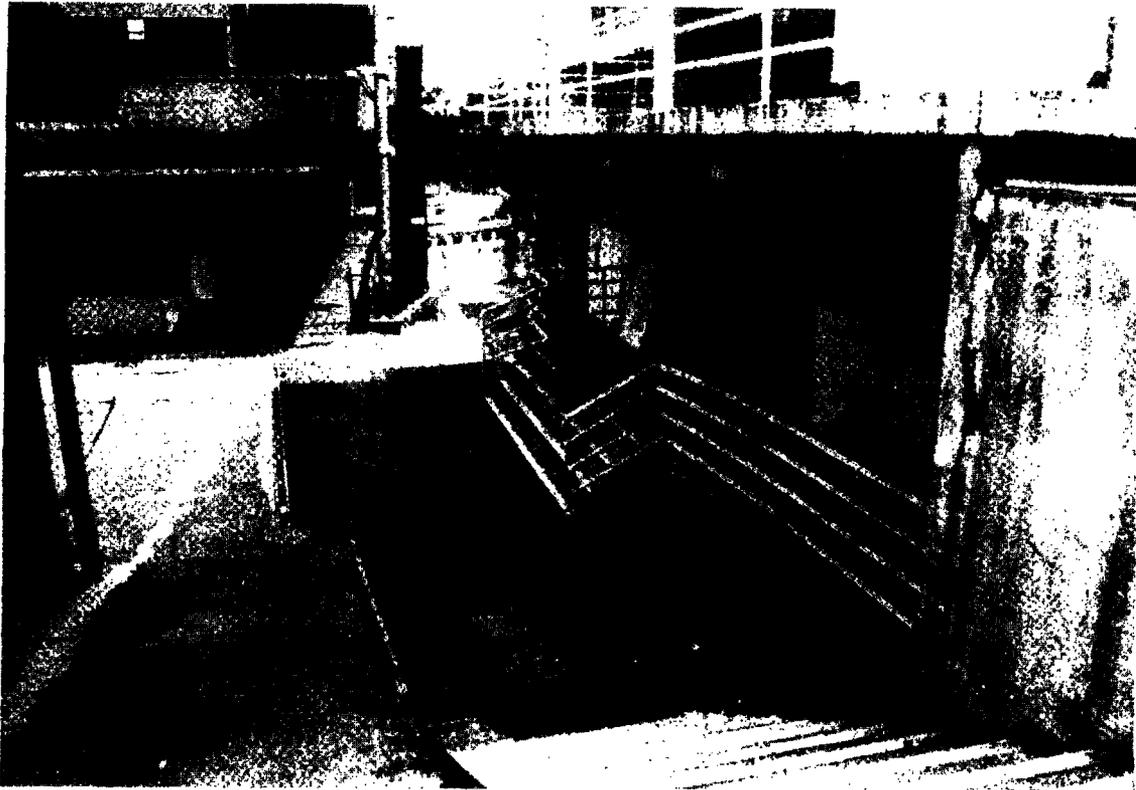


Figure 5.79 Tohoku Institute of Technology, walkway and north entrance of building 5 shows settlement of backfill along length of building.

3.12 this area of Sendai is quite hilly. The underlying stable terrace deposits provide a good foundation for buildings. The Engineering and Architecture Building on the Campus is a nine-story reinforced concrete frame structure with pile foundation approximately 10 years old. The structure was designed for a peak ground acceleration of 0.2g. A general view is shown in Figure 4.4 and plans and elevations are shown in Figure 4.5. The building is instrumented with two strong motion accelerometer instruments on the ground floor and the ninth floor. The records are discussed in detail in Chapter 4. The maximum accelerations recorded were 0.24 g at the ground floor and 1.0g on the ninth floor, both in the N-S direction.

The building performed very well in the earthquake. The February 1978 earthquake caused some cracking in shear walls and window breakage. The maximum ground floor acceleration measured then was 170 gal. After the June earthquake, the diagonal cracks had widened, but they still can be easily repaired. Figure 5.80 shows an interior transverse wall at the ground floor. The decorative glazed tile veneer has cracked and spalled along a diagonal crack in this wall. A number of windows on the upper stories were broken out and bookcases and filing cabinets were overturned. The main structural elements of the building appeared to be intact; however, minor cracks in the structural frame were reported at the lowest levels. Assuming that the first mode dominated the dynamic response, the maximum displacement amplitude at the ninth-story, computed from $A/(2\pi f)^2$ in which $A = 980 \text{ cm/sec}^2$ and $f = 1 \text{ Hz}$, was about 25 cm (10 in).

5.5 Residences

Sunny Heights Apartment Building (No. 38, Figure 5.3). This 190-unit private apartment building (Figure 5.81) is located on the east side of Sendai city on soft ground. It is a 14-story steel and reinforced concrete structure with a pile foundation, L-shaped in plan, which was built in two sections about two years ago. The L-shaped plan is not conducive to earthquake resistance because torsional effects may be amplified. The earthquake caused numerous diagonal cracks throughout the height of the building, particularly around doorways and window openings, as shown on the east face of the building in Figure 5.82. The extensive cracking in the nonstructural panels adjacent to doorways created major problems for occupants attempting to open doors and windows in the first ten stories. The most severely damaged panels were oriented in the N-S direction. Despite the extensive damage to nonstructural elements, the main loadbearing structural members appeared to be undamaged by the earthquake.

There was extensive evidence of ground cracking and settlement adjacent to the foundation and the walkway surrounding the building, as can be seen in Figure 5.83, where the support post below the bottom rail of the fence is exposed. The ground adjacent to the foundation subsided several inches in some cases. Portions of the parking area around the building appeared to have settled about 18 in (460 mm). There was a large water shortage tank located on top of the roof. It was shaken loose from its anchorage when the anchor bolts failed and the horizontal movement also caused the supply pipe to be damaged.

Single Family Dwellings. Major causes of the destruction to dwellings were landslides and rockfalls, inadequate foundations, and construction which lacked lateral bracing. Many homes in the Sendai vicinity have heavy tile roofs, and literally thousands of buildings had damaged roofs of varying degrees. Falling tile resulted in some injuries.

A major cause of deaths and injuries was collapsing or falling walls made of stone or concrete cinderblock. These walls serve as fences, for privacy, and as noise barriers. The Japan Building Code requires that walls over 1.5 m in height be reinforced in both directions. Although some of the walls that failed contained reinforcing, in most cases they contained less reinforcing than called for by the modern code. More fatalities resulted from falling walls containing inadequate reinforcing than from walls with none. Those with no reinforcing tended to crumble while those with reinforcing toppled as units on people who were nearby or who held onto them for stability when the earthquake occurred. In some cases, the masonry block cores were grouted but the reinforcing steel had been omitted.

Figure 5.84 shows an example of the ground cracking resulting from subsidence in one of the hilly areas in Sendai. The loss of foundation support has caused extensive cracking in the building walls. In Figure 5.85, the front steps and breezeway have separated some 30 cm

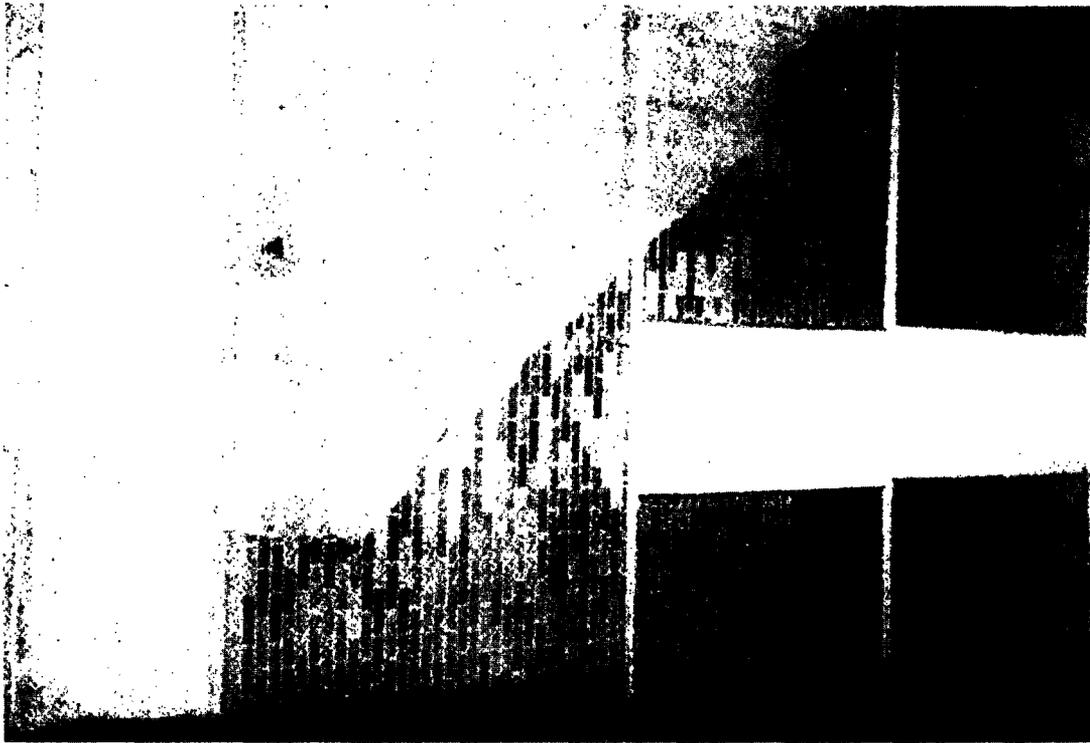


Figure 5.80 Tohoku University Engineering Building. Damage to glazed tile veneer of shear wall at ground level.

Figure 5.81 Sunny Heights Apartment Building, Sendai. General view from the southwest.





Figure 5.82 Sunny Heights Apartment Building. Detail of cracking of panels adjacent to doorways. Such cracking was typical at all levels on the east facade of the structure.

Figure 5.83 Sunny Heights Apartment Building. Ground cracking and settlement adjacent to walkway surrounding the building.





116

Figure 5.84 Sendai. Damage to single family residence due to loss of foundation support. (Japan National Land Agency photograph)



Figure 5.85 Sendai. Damage to single family residence due to ground settlement. (Japan National Land Agency photograph)

from the remainder of the structure due to ground settlement. There were many instances where tile roofs were badly damaged even when the structure remained standing (Figure 5.86).

Two examples of collapsed masonry-unit walls are shown in Figures 5.87 and 5.88. The wall shown in Figure 5.87 was not reinforced, and crumbled during the earthquake. The wall in Figure 5.88 contained reinforcement but was not anchored adequately to its foundation and toppled over practically as a unit.

Many single family dwellings were undamaged by the earthquake and, perhaps surprisingly, undamaged homes were found adjacent to larger engineered buildings that had been damaged. In a residential neighborhood at the bottom of the slope south of building 5 at Tohoku Institute of Technology, there was no visible damage to walls or tile roofs in any of the houses. Similarly, only minor damage could be observed to homes at the bottom of the bluff next to Tonan High School.

5.6 Summary

Considered collectively, severe damaged or collapsed reinforced concrete buildings shared a number of common features. Probably most significant, they were all designed prior to the 1971 revisions to the building code, at which time detailing requirements became more stringent. These older structures probably had little ductility and energy-absorbing capacity due to the use of undeformed bars and widely spaced column ties, insufficient ties and anchorage of reinforcement at beam-column joints, failure to provide hooks on ties, etc. None of the columns in failed buildings appeared to be spirally reinforced, which would be more ductile in their behavior. Damaged buildings frequently had flexible first stories and rigid upper stories. Building layouts were irregular and caused structural discontinuities. Partial infilled spandrel walls between columns contributed to many column failures. In some cases, the fate of an entire building rested on the integrity of a single column or wall. Mechanisms for load transfer following local failure through good floor plans, longitudinal spline walls and returns on shear walls would reduce the occurrence of complete collapse following failure of a single element. Stiffer structures with shear walls tended to have less damage than more flexible buildings.

It should be borne in mind that many of the buildings investigated have been through two recent major earthquakes (February 20 and June 12, 1978) without suffering damage. The total damage due to the June 12th earthquake constitutes a small percentage of the total capital investment in buildings and structures, despite recorded ground accelerations of as high as 0.25g to 0.30g.

5.7 References

- 5.1 Okamoto, S., Introduction to Earthquake Engineering, John Wiley, 1973 (Chapter 8, esp).
- 5.2 Standards for Aseismic Civil Engineering Construction in Japan, Ministry of Construction Standard No. 1074.
- 5.3 Watabe, M., "Summary of Present Codes and Standards in the World," 1978.
- 5.4 "Design Essentials in Earthquake Resistant Buildings," published by the Architectural Institute of Japan, Elsevier Publishing Co., London, 1970.
- 5.5 Uniform Building Code, 1976 Edition, International Conference of Building Officials, Whittier, CA. 1976.
- 5.6 "Tentative Provisions for the Development of Seismic Regulations for Buildings," Nat. Bur. of Stand. Special Publication SP510 (ATC 3-06), Washington, D.C., June 1978.
- 5.7 "Building Code Requirements for Reinforced Concrete," (ACI 318-77), American Concrete Institute, Detroit, MI, 1977.

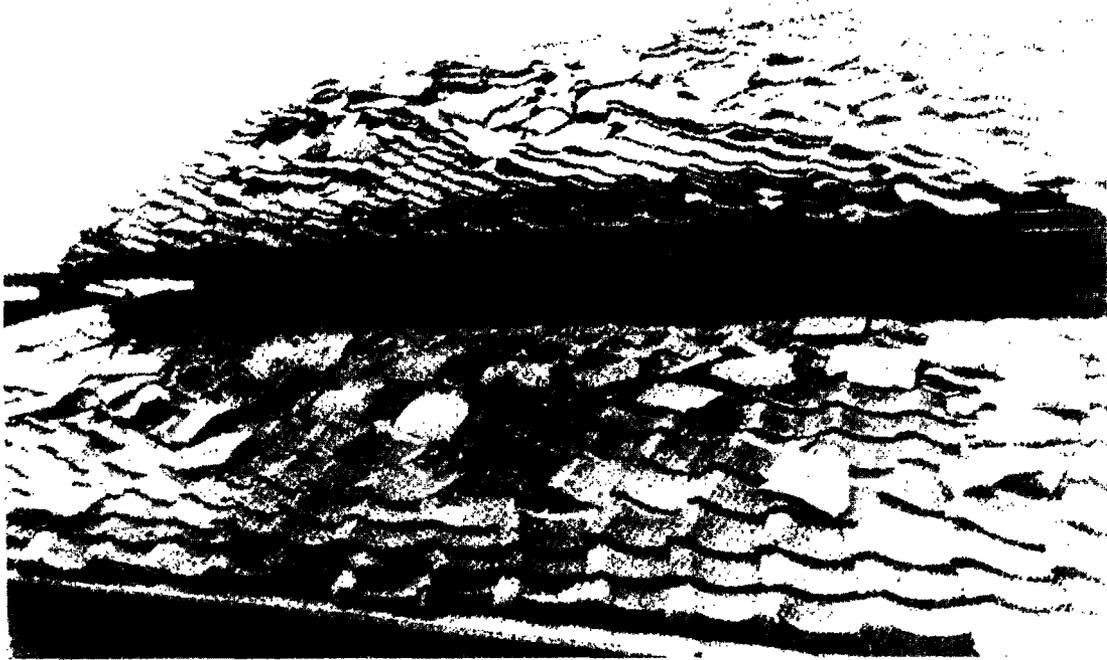


Figure 5.86 Typical damage to tile roofs in Sendai (Japan National Land Agency photograph)

Figure 5.87 Failure of unreinforced concrete masonry wall in Sendai (Japan National Land Agency photograph)



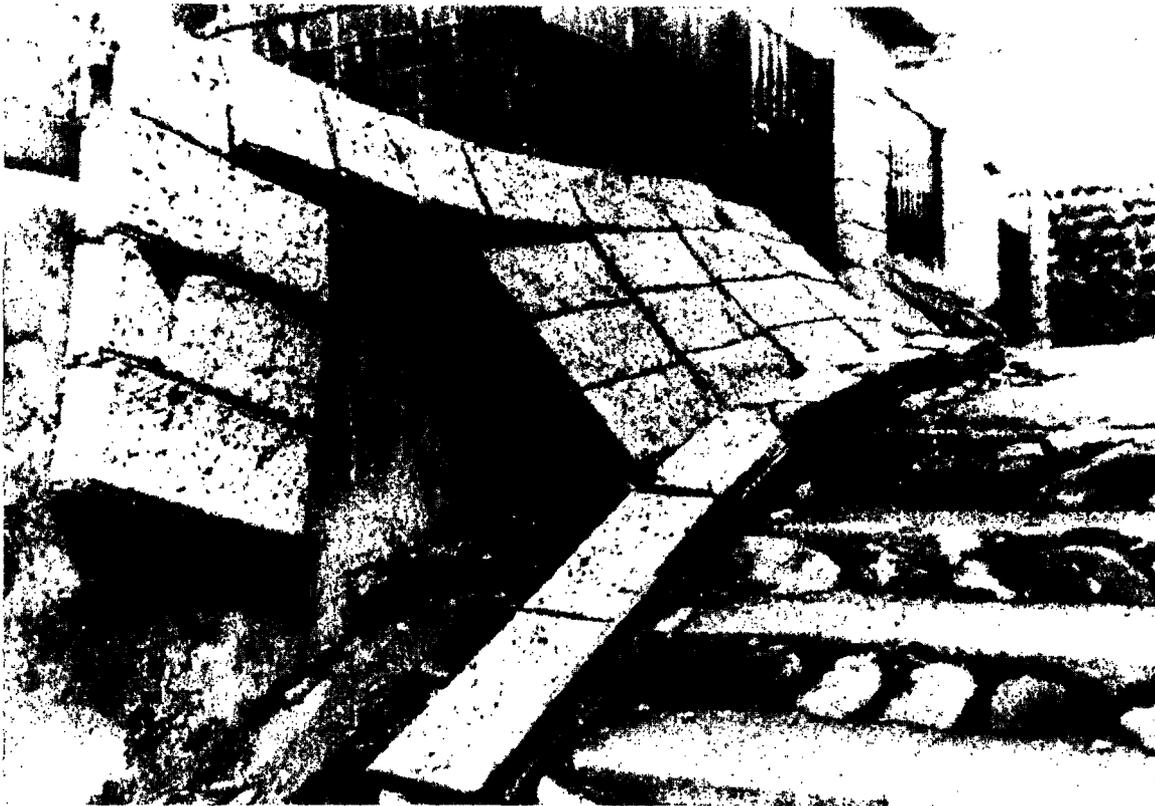


Figure 5.88 Failure of a reinforced concrete masonry privacy wall in Sendai.
(Japan National Land Agency photograph)

6. EFFECTS ON INDUSTRIAL FACILITIES AND LIFELINES*

6.1 Introduction

As discussed in Chapter 2, the preliminary Japanese estimates of damage at the end of June, 1978 amounted to approximately \$830 million. Of this total \$455 million was to factories, stores and other business establishments. This represents about 55 percent of the total damage. Damage to transportation, electrical, gas, and other lifeline facilities also represents a substantial proportion of the remaining damage. Of course, these figures do not include secondary types of damage, such as lost production for factories, lost revenue for power and gas utilities, etc. Thus, losses to industry and other business establishments dominate the damage statistics from the Miyagi-ken-oki earthquake of June 12, 1978. In this respect, the earthquake is very different from the majority of damaging earthquakes that have been reported in the literature.

Most of the significant structures in the Sendai area are modern structures, designed under advanced earthquake engineering concepts. The construction and inspection practices also appear to be of generally excellent quality. However, most of the capital investment in industrial facilities is concentrated in equipment systems, which typically are not protected against earthquakes to the same degree as the buildings which house them. This lower level of seismic resistance may explain why a high proportion of the total damage was caused to factories, stores and other business establishments.

A small number of industrial facilities and lifeline structures were briefly inspected. Damage varied from negligible, at the Fukushima Nuclear Power Plant, to severe, at the Sendai Gas Facility. Sendai is a large industrial city, with more than 6,500 business/manufacturing firms. The investigated sample of facilities represents a small fraction of the damage caused by the earthquake and of the facilities that were affected.

At the time of the reconnaissance, Japanese engineers were already conducting investigations of some of the facilities mentioned herein, and detailed reports will be available in the future. This is particularly true of the power facilities in and near Sendai. Let us hope that much of this important information will be translated into English.

This section of the report contains observations that were collected and recorded in a very brief time, and undoubtedly contains some data errors. In addition, no attempt is made here to analyze the structures and equipment or their performance. The primary objective of this report, and of the reconnaissance investigation, is to observe the performance of earthquake-resistant and other buildings, structures, and equipment.

The maps of Figures 1.1, 5.3 and 6.1 show the sites and facilities treated in this section of the report.

6.2 Fukushima Nuclear Power Plant Complex

The Fukushima Nuclear Power Plant Complex is owned and operated by the Tokyo Electric Power Company. It is located on the Pacific coast of Fukushima Prefecture, about 7 km south of the town of Namie, and is southeast of the town of Fukushima. The site is approximately 140 km from the epicenter of the earthquake. According to Chapter 3, faulting may have extended as much as 60 km west of the epicenter. In that case, the plant site may be located about 80 km (50 mi) from the nearest location of the source of energy, as shown in Figure 1.1

The complex has six nuclear units, as shown in Figure 6.2, for a total of approximately 4,700 MW, and is the largest nuclear power complex in the world. The site is heavily instrumented with strong motion accelerometers. Numerous records were made; the peak ground acceleration was 0.125 g and the duration of strong motion was in excess of 30 seconds. Because most U.S. nuclear power plants are designed to criteria that is similar to the seismic motion to which the Fukushima site was exposed, this earthquake represents a unique event. This is the first

* Prepared by Peter I. Yanev, URS/John A. Blume and Associates, San Francisco, California.

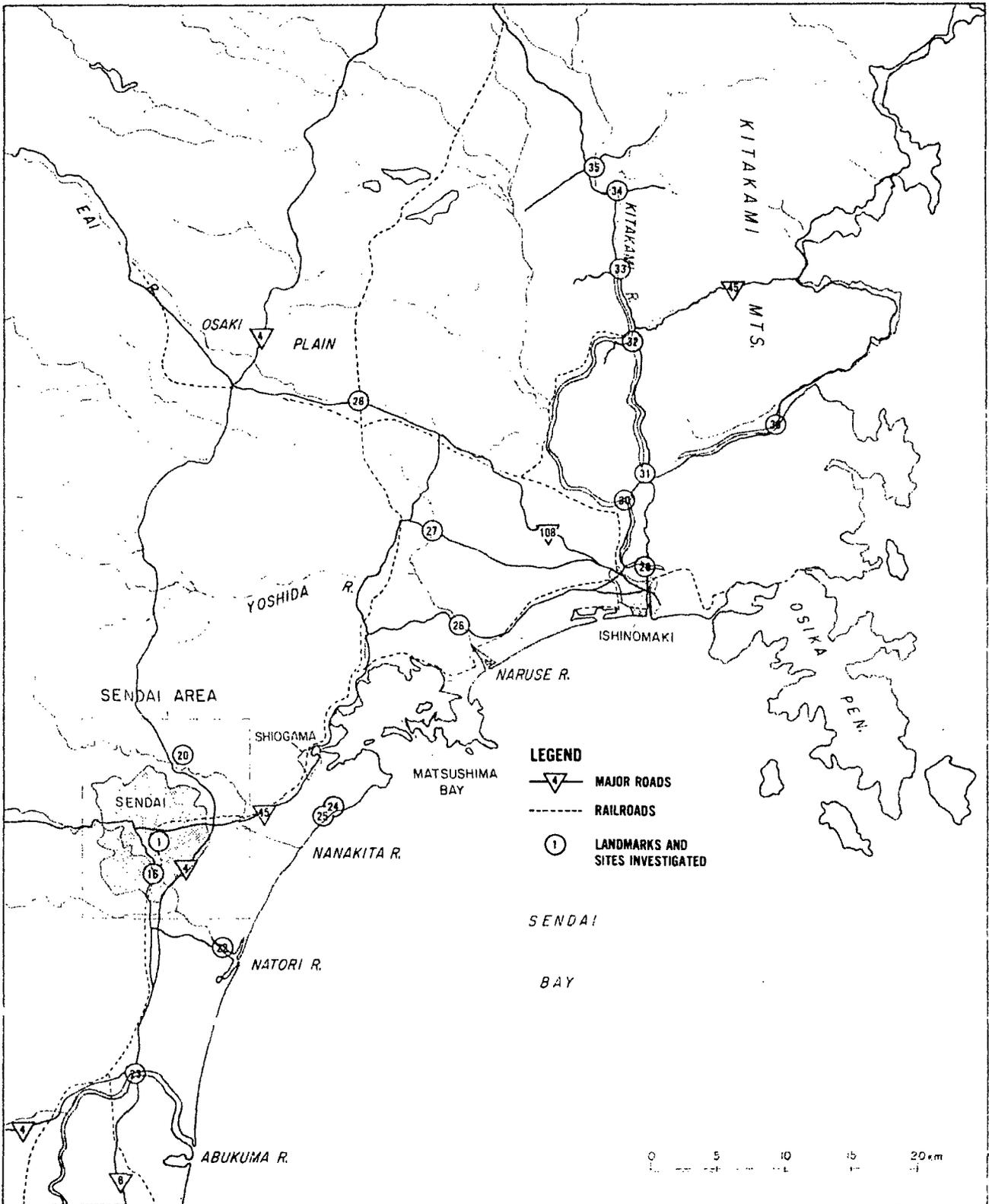


Figure 6.1 Map of Miyagi Prefecture, showing major landmarks and sites of damage visited. (see Table 5.1 for identification).



Figure 6.2 Fukushima Nuclear Power Plant: a general view showing the six units. They are, from right to left, Unit 6, Unit 5, Unit 1, Unit 2, Unit 3, and Unit 4. (Tokyo Electric Co. photograph)

time that a modern nuclear power plant was exposed to strong ground motion with long duration. In addition, the presence of six units at one site represents a good statistical sample.

Table 6.1 summarizes some of the pertinent data for this six-unit complex:

At the time of the UJNR team visit, June 23, 1978, 11 days after the earthquake, Units 1, 2, 3 and 5 were operating; Unit 6 was still under construction, but was essentially completed, and it is believed that Unit 4 was scheduled to go into commercial operation soon. The above table indicates that the expected date of commercial operation for the unit was sometime in October of 1978.

Units 1 through 5 have a Mark 1 (light-bulb-torus) type of containment structure; Unit 6 has a Mark 2 (over/under) type of containment (see Figures 6.3 and 6.4). USR/Blume Engineers formulated the seismic design criteria for the plant and performed the original seismic analyses for the General Electric Company and the Tokyo Electric Power Company.

The plants are founded on a competent soft mudstone formation with a thickness in excess of 300 m. Extensive cuts were necessary to level the site and to reach the mudstone, which has a shear wave velocity of about 600 m/sec.

Unit 1 was designed for a peak ground acceleration of 0.18g and a response spectrum based on the Taft record from the Southern California (Kern County) earthquake of 1952.

The reconnaissance team inspected the exterior of Unit 1 and the exterior and interior of Unit 6, including the containment structure, the reactor vessel pedestal, some of the equipment on the refueling floor, some of the equipment in the reactor building, the underside of the control rod drive in the containment, miscellaneous critical and non-critical piping, various critical and non-critical cable trays, the reactor building, the turbine building, the turbine overhead crane, and various auxiliary structures, equipment and tanks (see Figures 6.5 through 6.9). There was no damage or evidence of working of connections in any of the inspected areas. The only reported damage to the complex was to some non-critical electrical insulators, shown in Figure 6.10, some distance to the west of Units 1 and 2 (see the following discussion on the effects to electrical insulators at the Sendai Substation in Izumi, near the city of Sendai).

Units 1 and 6 are instrumented with between 20 and 30 strong motion accelerometers and much valuable information was obtained from the earthquake. The peak ground acceleration, which could be considered to be a "free-field" acceleration (see Figure 6.11) is 0.125g. (EW direction). The corresponding accelerations in the NS direction and Up/Down directions are 0.100g and 0.050g. The strong motion exceeds 30 sec in duration. The reported maximum response acceleration in the buildings is reported to be about 0.5g. Higher accelerations would be expected in instrumented equipment or piping systems. It is interesting that records were obtained from instruments located on the base slabs of the two units and at downhole instruments, about 30 to 40 m below two of the containments. Thus, it may be possible to conduct a detailed soil-structure interaction study for the plant.

Tokyo Electric Power Company is also conducting model studies of the plant at the site. A 1/15th scale model of the containment has been constructed a few hundred yards away from the nuclear units. The model, shown in Figure 6.12, was also instrumented, including another downhole instrument, and additional records are available from the study. At the time of the investigation the company was beginning to evaluate the recorded data.

6.3 New Sendai Power Plant, Tohoku Electric Power Company

The New Sendai Power Plant, owned and operated by the Tohoku Electric Power Company, is located on the Pacific shore, 15 km east of the center of Sendai. The site is adjacent to the Sendai refinery of the Tohoku Oil Company which suffered extensive damage from the earthquake (as discussed elsewhere in this chapter). The plant shown in Figure 6.13, has two Mitsubishi oil-fired boilers. Unit 1 was completed in 1971 and has a capacity of 350 MW; the 600-MW Unit 2 was completed in 1973 and is the largest unit of the company. The total capacity of the Tohoku Electric Power Company is 5,715 MW, this plant representing about 17 percent of that capacity.

Table 6.1

	Net MWe	Type	Reactor Supplier	Generator Supplier	Architect Engineer	Constructor	Con- struc- tion stage (%)	Commercial Operation	
								Orig. sched- ule	actual or ex- pected
Fukushima One 1 (Fukushima)	460	BWR*	GE/Toshiba	GE/Hitachi	Ebasco	Kajima	100		3/71
Fukushima One 2 (Fukushima)	784	BWR	GE	GE/Toshiba	Ebasco	Kajima	100		7/74
Fukushima One 3 (Fukushima)	784	BWR	Toshiba	Toshiba	Toshiba	Kajima	100		3/76
Fukushima One 4 (Fukushima)	784	BWR	Hitachi	Hitachi	Hitachi	Kajima	92	6/76	10/78
Fukushima One 5 (Fukushima)	784	BWR	Toshiba	Toshiba	Toshiba	Kajima	96	12/75	4/78
Fukushima One 6 (Fukushima)	1100	BWR	GE	GE/Toshiba	Ebasco	Kijima	78	10/76	10/79

* BWR - Boiling Water Reactor
(Source: Nuclear News Buyers Guide, mid-February 1978)

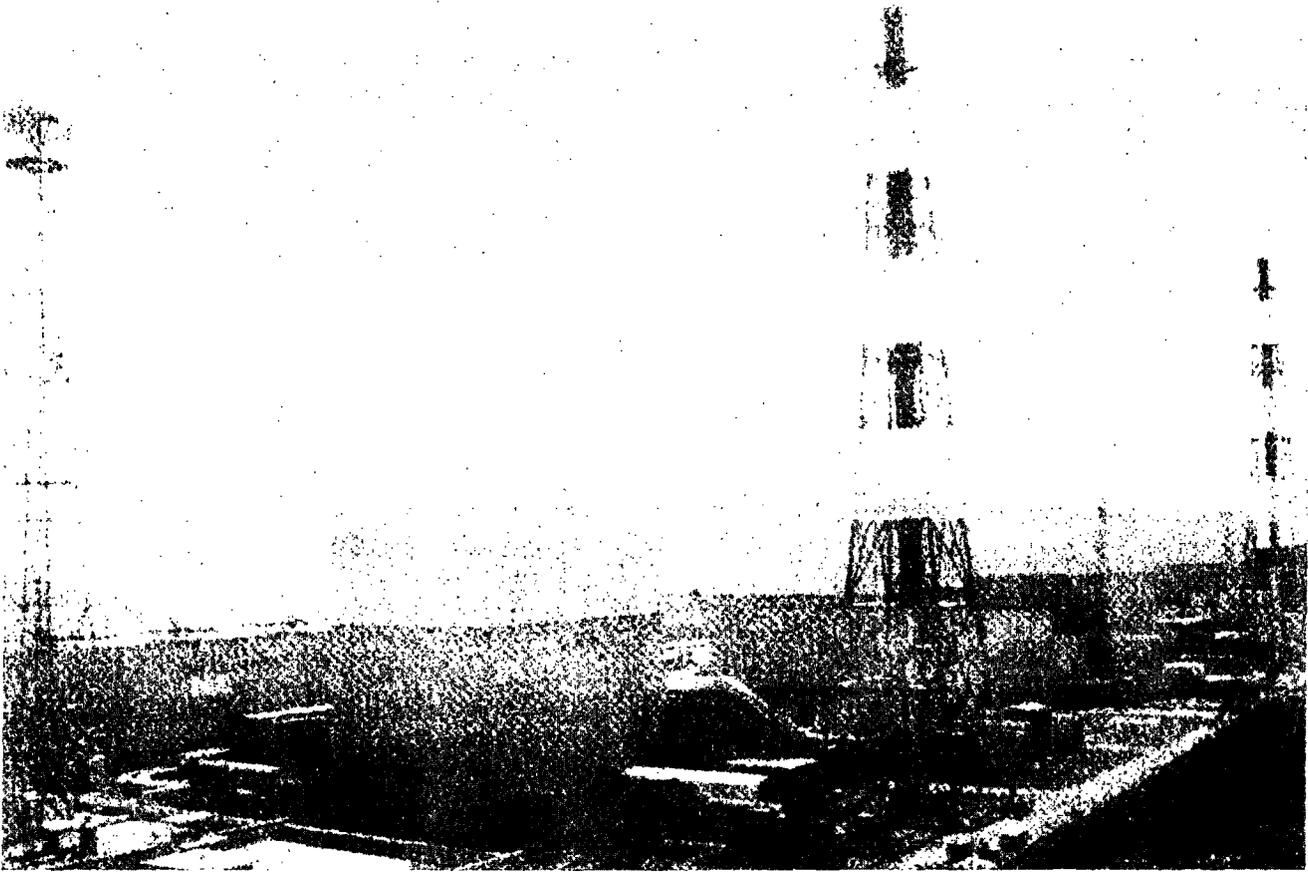


Figure 6.3 Fukushima Nuclear Power Plant: the containment structures of Units 1 through 4. None of these structures showed damage. (Tokyo Electric Co. photograph)

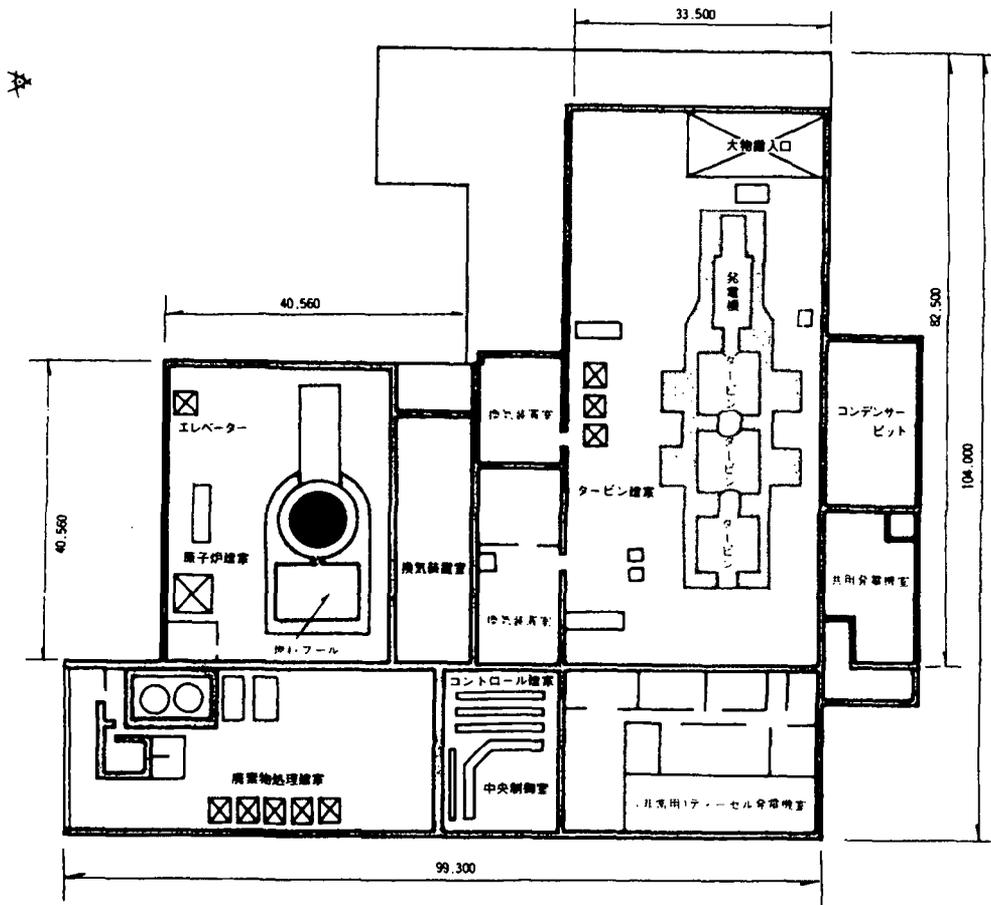


Figure 6.4 Fukushima Nuclear Power Plant: Typical elevation view through the reactor/containment building and the turbine building and a plan view across the refueling floor of the reactor building and the operating floor of the turbine building.

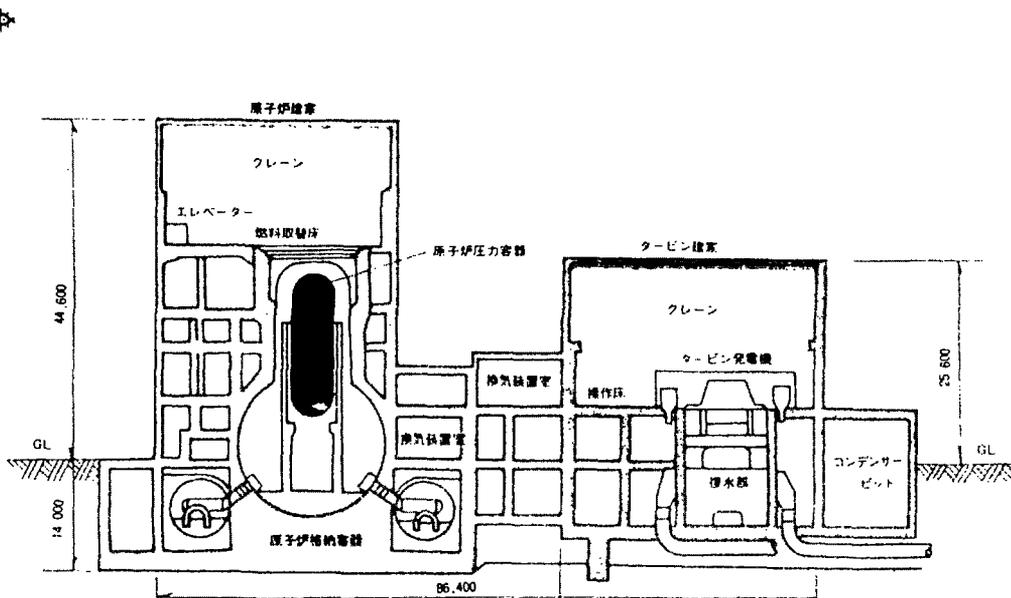


Figure 6.5 Fukushima Nuclear Power Plant: large, undamaged safety related water storage tanks that are located between units 1 and 5.

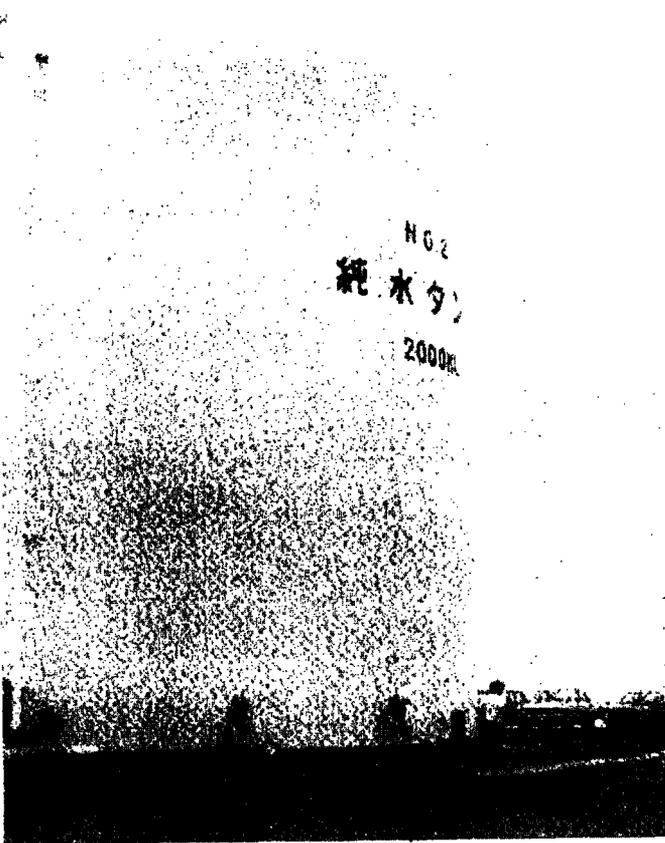


Figure 6.6 Fukushima Nuclear Power Plant: a view of the braced steel frame roof and the overhead crane of the turbine building of Unit 6.

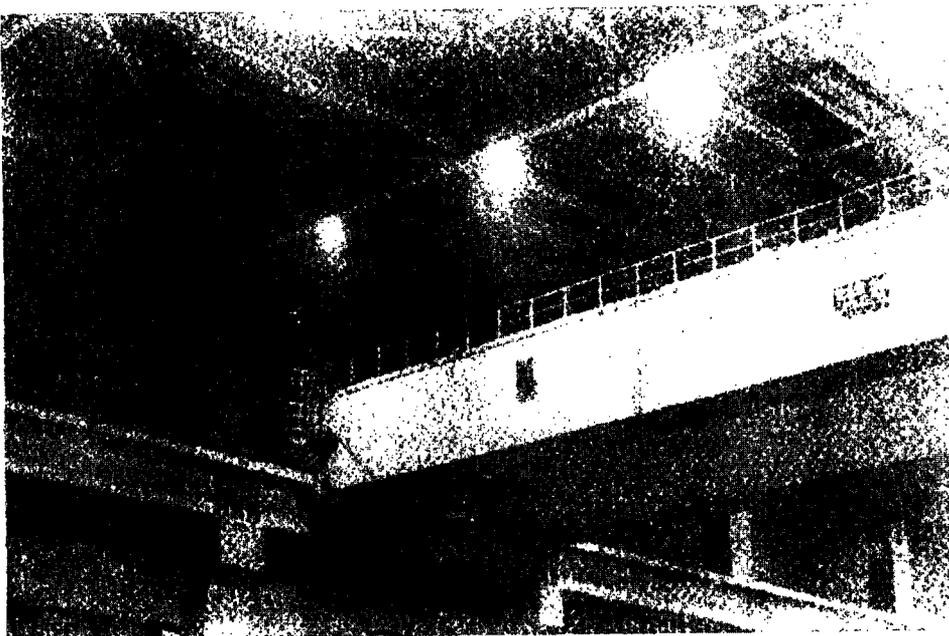




Figure 6.7 Fukushima Nuclear Power Plant: a partial view of the Unit 6 control rod drive and its supports. The unit is still under construction and was more than 95% completed at the time of the reconnaissance. There was no apparent damage or any evidence of working connections at this system or at the other systems of Unit 6 that were examined.

Figure 6.8 Fukushima Nuclear Power Plant: a typical view of massive seismic and/or pipe whip bracing of critical piping inside the reactor building of Unit 6. The equipment showed no evidence of damage. This unit is still under construction.



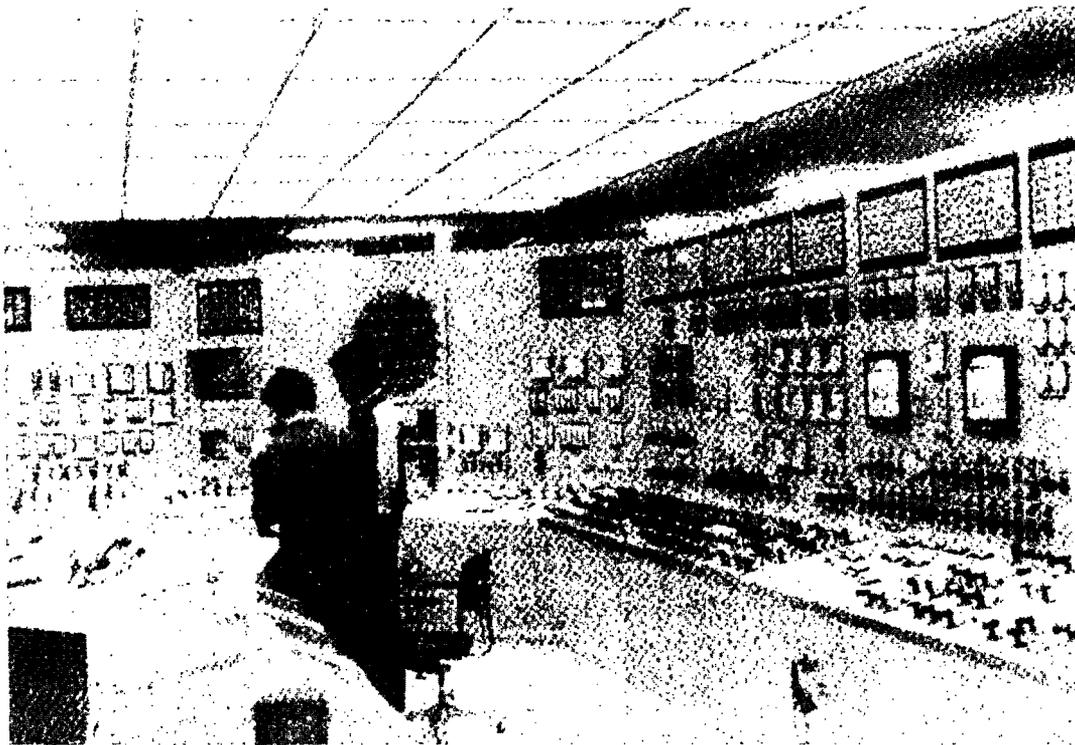


Figure 6.9 Fukushima Nuclear Power Plant: a partial view of the control room of Unit 5. At the time of the visit on June 23, 1978, 11 days after the earthquake, this unit was operating.

Figure 6.10 Fukushima Nuclear Power Plant. Broken ceramic insulators were the only damage reported for the site. The damaged insulators had been replaced, as illustrated above, within hours after the earthquake and before the reconnaissance visit.



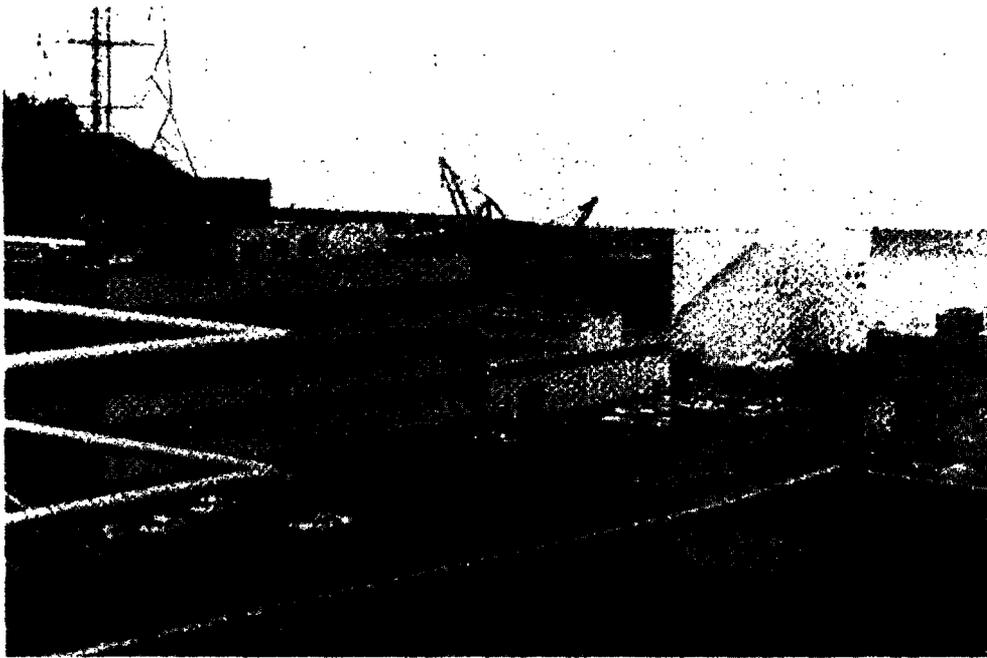


Figure 6.11 Fukushima Nuclear Power Plant: a view of some of the auxiliary structures to the north of Unit 1. Free-field acceleration was recorded in the water treatment building (the white, 1-story building in the middle of the photograph), which is located approximately 100 m from the Unit 1 containment structure. The SMAC instrument recorded a peak ground acceleration of approximately 0.125g.

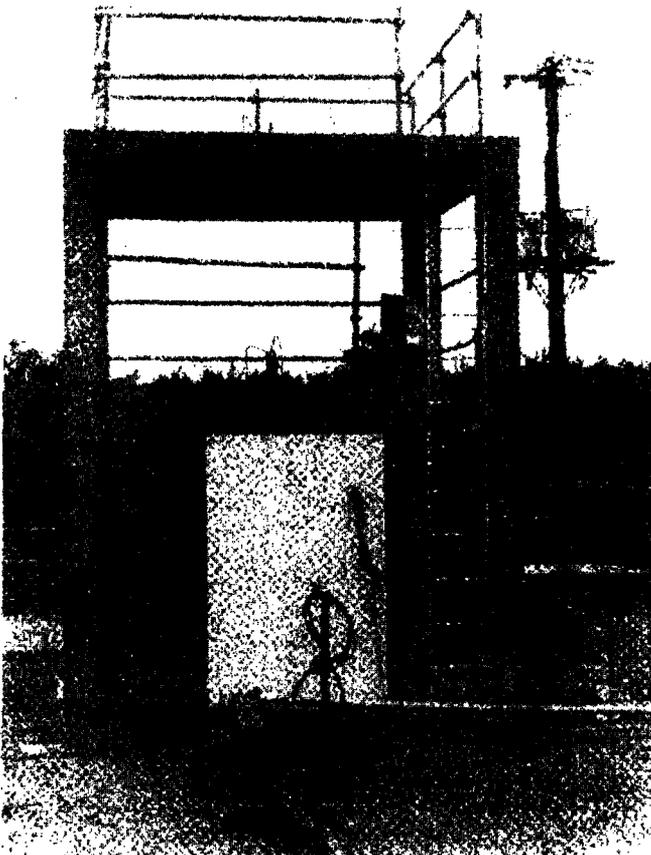


Figure 6.12 Fukushima Nuclear Power Plant: view of the 1/15th scale model of the containment of one of the nuclear units. The free field and downhole instrumentation is located away from the test structure (note the cables to the right).

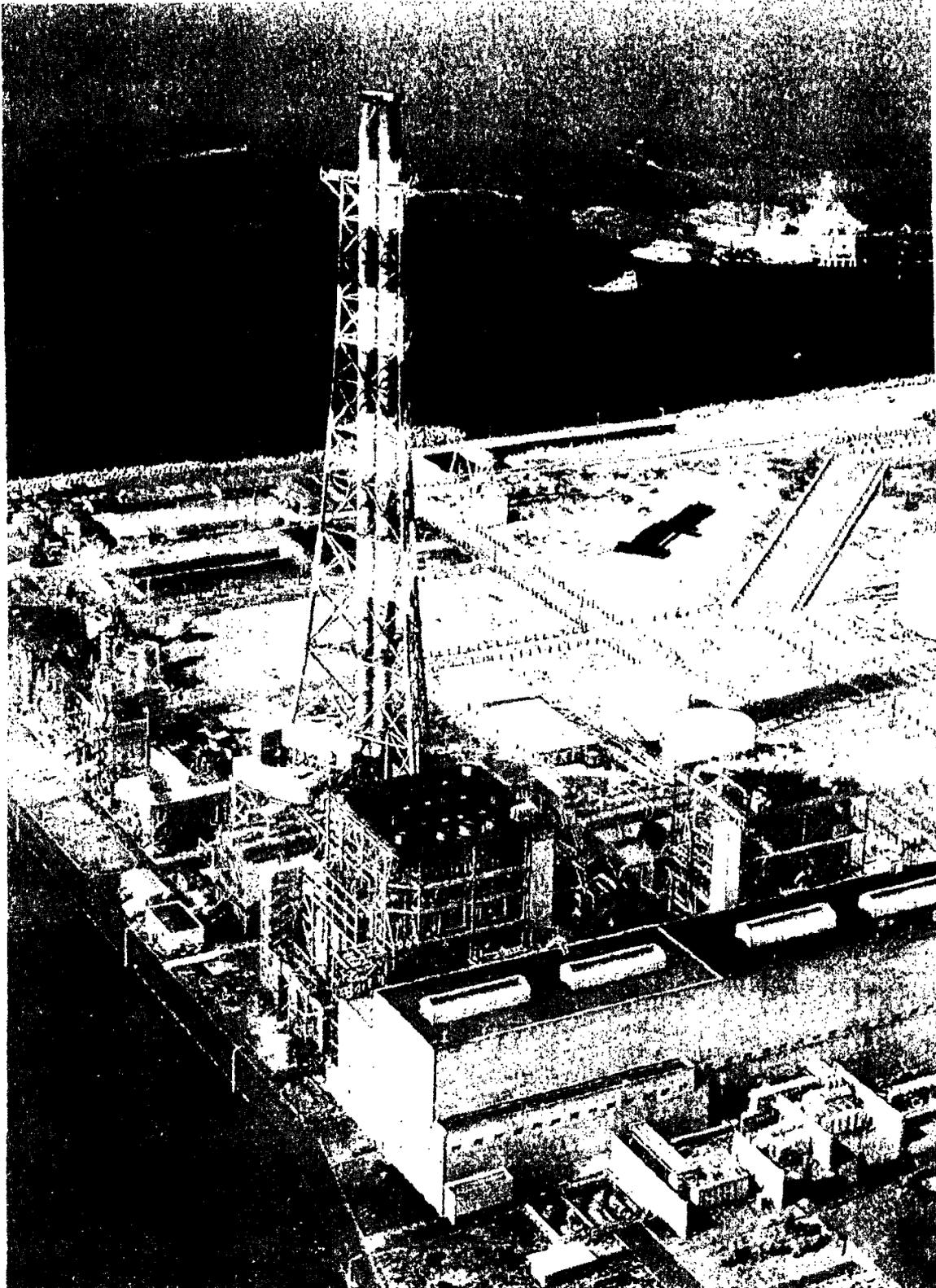


Figure 6.13 New Sendai Power Plant, Tohoku Electric Power Company: a general view of the two-unit, oil-fired power plant. The turbine building is in the foreground, and the two boiler structures are in the background. Unit 2, the large unit, has a 600-MW capacity. Unit 1 has a capacity of 350 MW. Note the massive seismic bracing to the combined stacks and to the boiler support frames. (Tohoku Electric Power Co. photograph)

Because the SMAC accelerograph at the station was being inspected at the time of the earthquake, no records were obtained. However, the plant's seismic alarm, located at the level of the turbine operating floor, was triggered at approximately 0.15g. Because the plant is closer to the epicenter of the earthquake and the assumed area of faulting (as discussed in Chapter 3), it may be assumed that the ground motion at the plant was somewhat stronger than in the city of Sendai where the recorded peak ground accelerations varied between 0.20 and 0.40g.

The plant is located in an area of recent alluvium and on filled land; the depth of unconsolidated sand is approximately 15 m (45 ft).

Both of the units were damaged during the earthquake, and the plant was shut down for 6 days for repairs. Total damage to the facilities of the Tohoku Electric Power Company is approximately \$15 million; estimated damage to the plant accounts for about 10 percent of the loss. The total assets of the company in property, plant and equipment for Fiscal Year 1976 were \$3,840 million. Damage from this earthquake caused a loss of about 0.4 percent of those assets. The plant was operating at the time of the investigation of June 24th, 12 days after the earthquake.

Three types of damage occurred at the plant: (1) damage due to local, minor settlement, (2) damage to the structural and architectural elements of buildings, which was minor, and (3) damage to the equipment, which constituted the bulk of the loss.

Minor settlement occurred throughout the site. Much of this settlement occurred in the vicinity of buried piping (Figure 6.14). About 1 cm of settlement occurred at the intake structure and the paving around the structures was cracked; however the structure was operational and did not seem to require repairs (Figure 6.15).

Building damage was limited to some of the interior walls of the administration building and to the facing precast panels of the turbine buildings (Figure 6.16). Some of these panels were loosened; presumably the attachments to the steel framing were damaged.

Both Unit 1 and Unit 2 suffered damage to tubing inside the boilers (Figure 6.17). A small furnace platen cooler tube inside the slag screen was sheared in the Unit 1 boiler (Figure 6.18). A similar failure occurred in the boiler of Unit 2 to one of the reheater spacer tubes. The suspended boilers and their structural supports also pounded against one another and also sustained some damage (Figure 6.19).

There was no other reported damage. The turbine pedestals and the operating floor of the turbine buildings in Japan are usually separated by a 3 to 4 inch gap and, in this case, there was no pounding between the two structures.

6.4 Sendai Substation, Tohoku Electric Power Company

The Sendai Substation of the Tohoku Electric Power Company is located on a low hill in the city of Izumi, about 7 km north-northeast of the center of Sendai. The substation is a large, multilevel complex. It was constructed during the last few years to the current Japanese seismic code, which specifies a minimum design acceleration of 0.20g for low-rise structures.

Figure 6.20 shows a general layout of the complex. The upper portion of the substation is the high-side 274 KV bus, and the lower portion of the substation is the low-side bus which is 154 KV. Locations of damage to equipment are circled in the figure.

Extensive cuts and fill were necessary because of the topography of the hill on which the station was located. The filled areas are indicated in Figure 6.20. Some of the fills, all of which were engineered, were as deep as 15 m (45 ft). The underlying bedrock is a competent, soft mudstone which was left exposed with slopes exceeding 60°. Due to seismic considerations, the most important electric components of the station were placed on the cut portions of the site, over a mudstone foundation. For example, all of the main transformers were placed on the cut sites, as shown in Figure 6.20. According to utility engineers, there seemed to be no difference in the amount of damage sustained by equipment whether on fills or on cuts. There was extensive damage to equipment in all parts of the facility. It

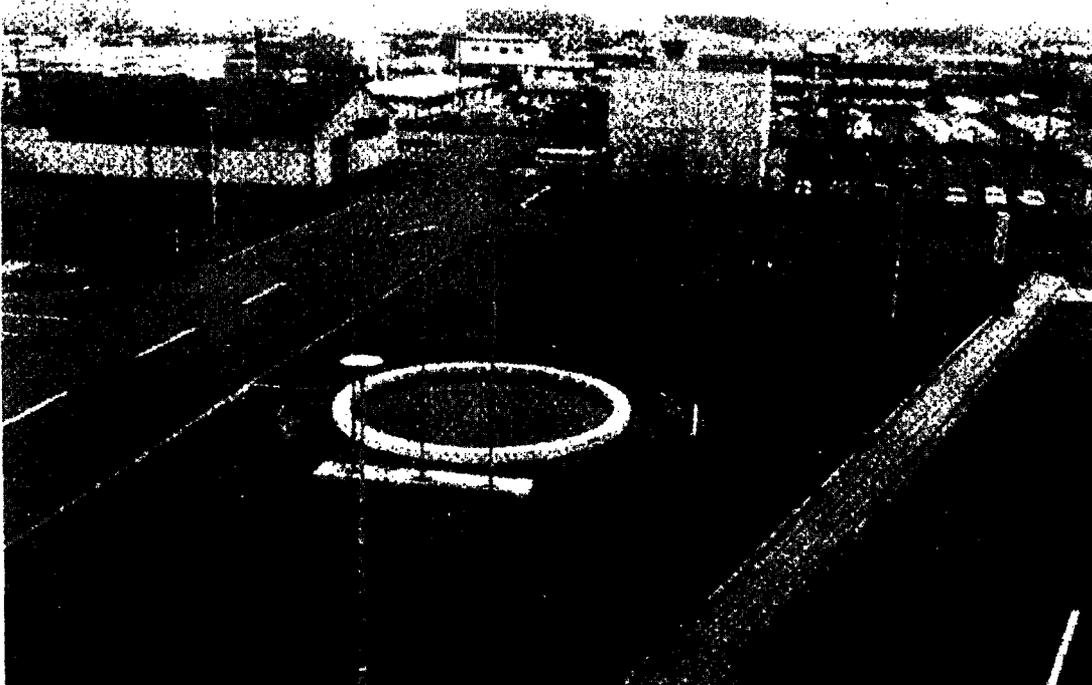
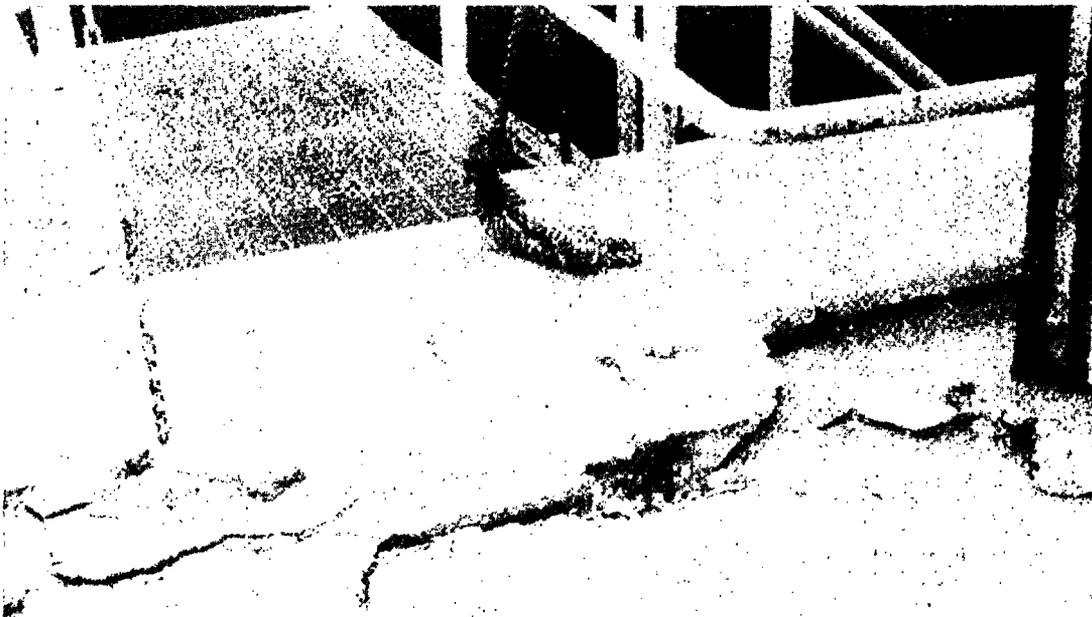


Figure 6.14 New Sendai Power Plant; Tohoku Electric Power Company: A view of the entrance area to the power plant showing settlement of fill and subsequent repair work to the pavement. The pavement settled approximately 15 cm (6 in) and was primarily in the vicinity of a backfilled underground pipeline.

Figure 6.15 New Sendai Power Plant, Tohoku Electric Power Company: damage around the water intake structure from minor settlement. Other examples of minor settlement were observed throughout the site.



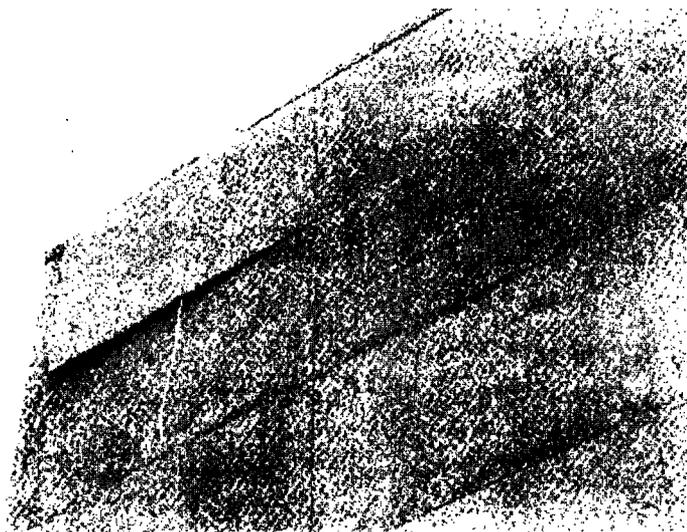


Figure 6.16 New Sendai Power Plant, Tohoku Electric Power Company: a loosened exterior facing panel in the turbine building. This was the only obvious damage to the exterior of the structure. The shear walls of the adjacent administration building showed extensive cracking.

Figure 6.17 New Sendai Power Plant, Tohoku Electric Power Company. The arrow points to the location of the damaged horizontal spacer tubes in the 600-MW boiler of Unit No. 2. (See Figure 6.18).

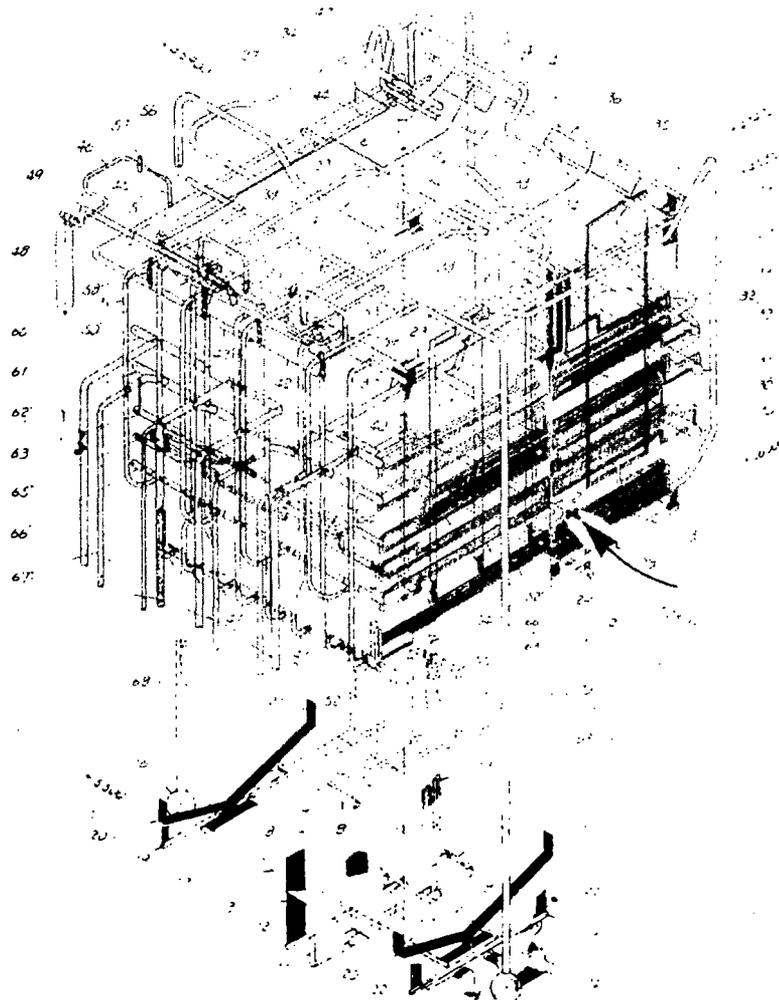




Figure 6.18 New Sendai Power Plant, Tohoku Electric Power Company: damage to the two boilers consisted of shearing of spacer tubes for the furnace platen cooler tubes inside the boiler. (Tohoku Electric Power Company photograph)

Figure 6.19 New Sendai Power Plant, Tohoku Electric Power Company: a view of the exterior of the boiler walls showing evidence that the suspended boiler had pounded against the surrounding support structure. (Tohoku Electric Power Company photograph)



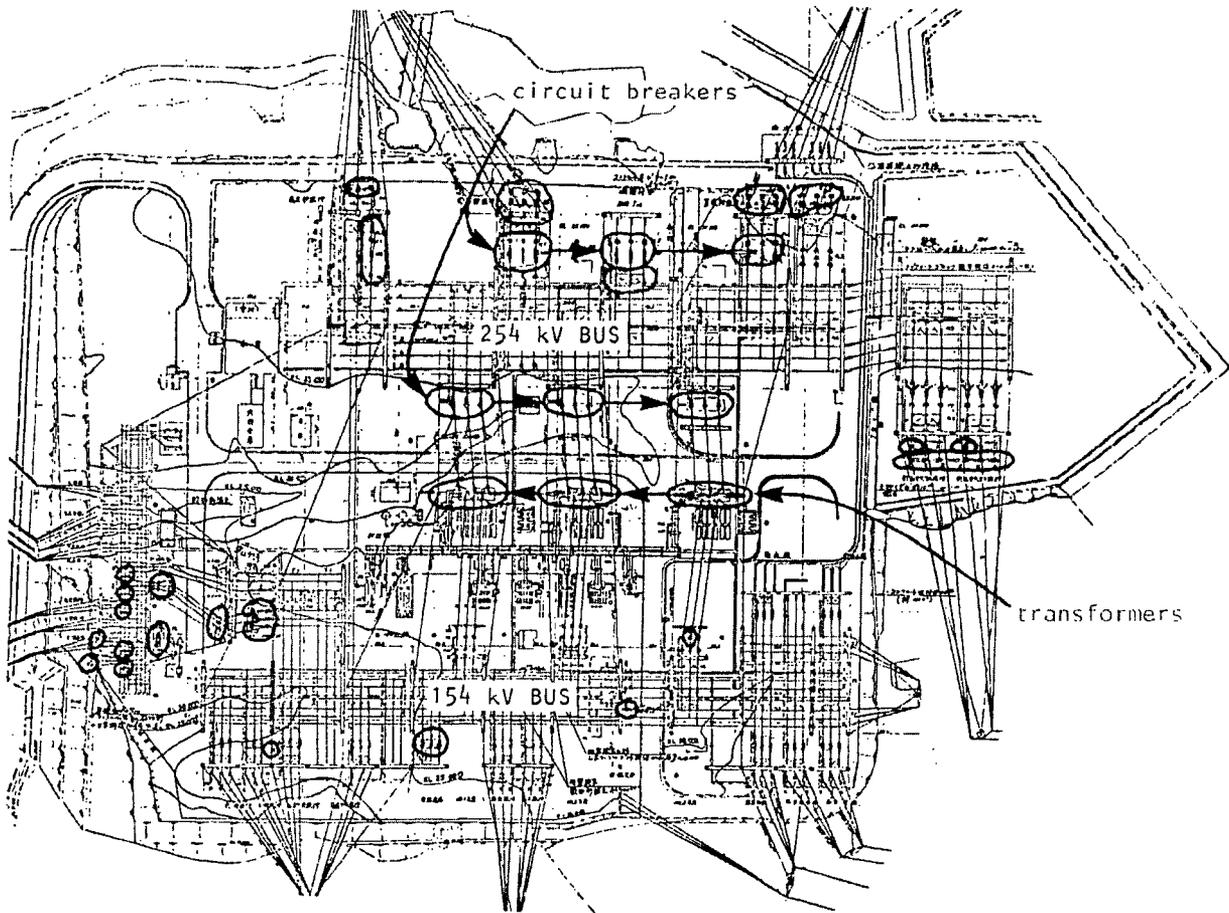


Figure 6.20 Sendai Substation, Izumi: plan of the facility showing the location of damaged equipment (circled). The solid contour lines indicate areas that were filled.

was immediately apparent during the investigation (June 24, 12 days after the earthquake), that all of the equipment was adequately anchored to its foundations, or braced. No overturning or other structural bracing failures were noted. Apparently, the damage was limited to various ceramic insulators in lightning arresters, potential devices, circuit breakers, transformers, bushings, reactors or line traps, switches, etc. Thus, there was a striking difference between the damage to this substation, as compared to the damage at the Sylmar Converter Station from the San Fernando, California earthquake of February 9, 1971. In the latter case much of the damage was caused by the overturning of equipment with inadequate anchorages or supports.

By June 24th much of the damage to the substation had been repaired (Figures 6.21 and 6.22), and the damaged equipment (Figures 6.23 through 6.27) had been dumped in piles on the periphery of the substation (Figure 6.28). Repairs were still going on to the bushings and lightning arresters of some of the main transformers (Figure 6.29), and various pieces of equipment had not yet been replaced. The total damage at the substation is estimated to be on the order of \$15 million.

A Japanese team has been assembled to conduct a special investigation of the performance of the substation during the earthquake.

6.5 Haranomachi Plant of Sendai City Gas Bureau

The Sendai City Gas Bureau's Haranomachi Plant, located approximately 3.7 km northwest of the center of Sendai, suffered major damage. The total collapse of a large propane gas holder (Figure 6.30) was partially responsible for the stoppage of gas for the city. It was estimated that gas services for the city would not be restored until the end of June, some three weeks after the earthquake. At the time of the investigation (June 25, 13 days after the earthquake) many restaurants in Sendai were closed because of lack of gas. According to Chapter 2 about 60 percent of the 200,000 households in Sendai are dependent on gas for heating and cooling, and as of June 28, 1978, 22,000 of these households were still without gas. An additional 10,400 households elsewhere in the prefecture were also without gas.

The holder diameter was 38 m; its height was 27 m. At the time of the earthquake, the holder contained 14,000 m³ of propane gas, at the relatively low pressure of 1 kg/m², and held water in a 9-m section at the bottom of the structure. The tank had at least two, but more probably three, telescoping sections constructed of riveted plate, 1 cm (3/8 in.) thick, stiffened with ring stiffeners at approximately 2 to 3 m. The tank was surrounded by an outside containment dike also constructed of riveted steel plate.

The collapsed holder caught on fire shortly after failure, and all of the stored gas was consumed. The fire burned out, or was extinguished, about 25 minutes later, and did not spread to the nearby high pressure propane tanks. The most serious damage to the gas facility was caused by the collapsing holder. It struck the nearby pipeway for many of the tanks at the plant, causing much damage to the piping systems and other associated equipment. Figure 6.31 shows the collapsed holder and the damaged pipeway just after the earthquake. At the time of the investigation a new pipeway had been erected on the concrete pedestals of the old pipeway, and repairs of the pipelines were proceeding, Figure 6.32. These pipes service the remaining undamaged gas tanks.

There was evidence of damage throughout the facility (Figures 6.33 through 6.38); however, none of the other tanks at the facility are believed to have suffered major damage. Some damage was due to pounding between buildings and pipes that penetrated the building walls (Figure 6.39). Unanchored pipe supports often moved on their pedestals, and reinforced concrete block structures suffered damage to their structural elements.

6.6 Sendai Refinery, Tohoku Oil Company Ltd.

Figures 6.40 through 6.49 give an overview of damage to the Sendai Refinery of the Tohoku Oil Company, Ltd., which is located on shore about 15 km east of the center of Sendai and adjacent to the New Sendai Power Plant. A plan of the refinery, which is a major installation and was completed in 1971, is shown in Figure 6.40. The refinery covers an area of 1,600,000 m². Its capacity is approximately 100,000 barrels/day.

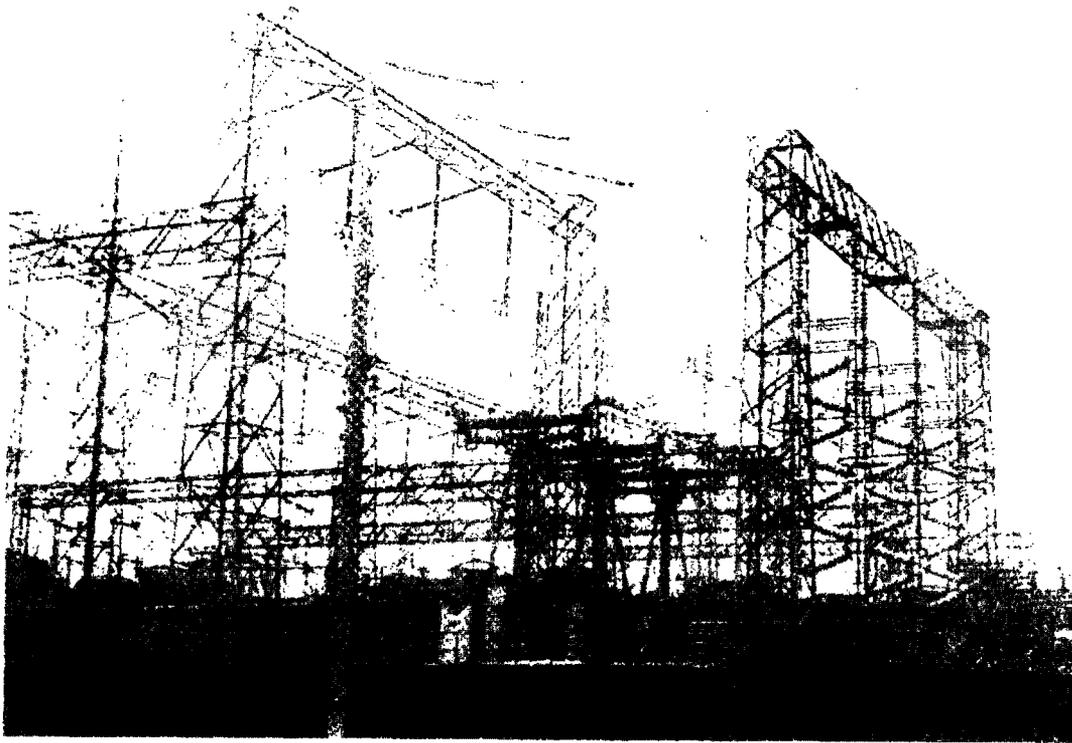
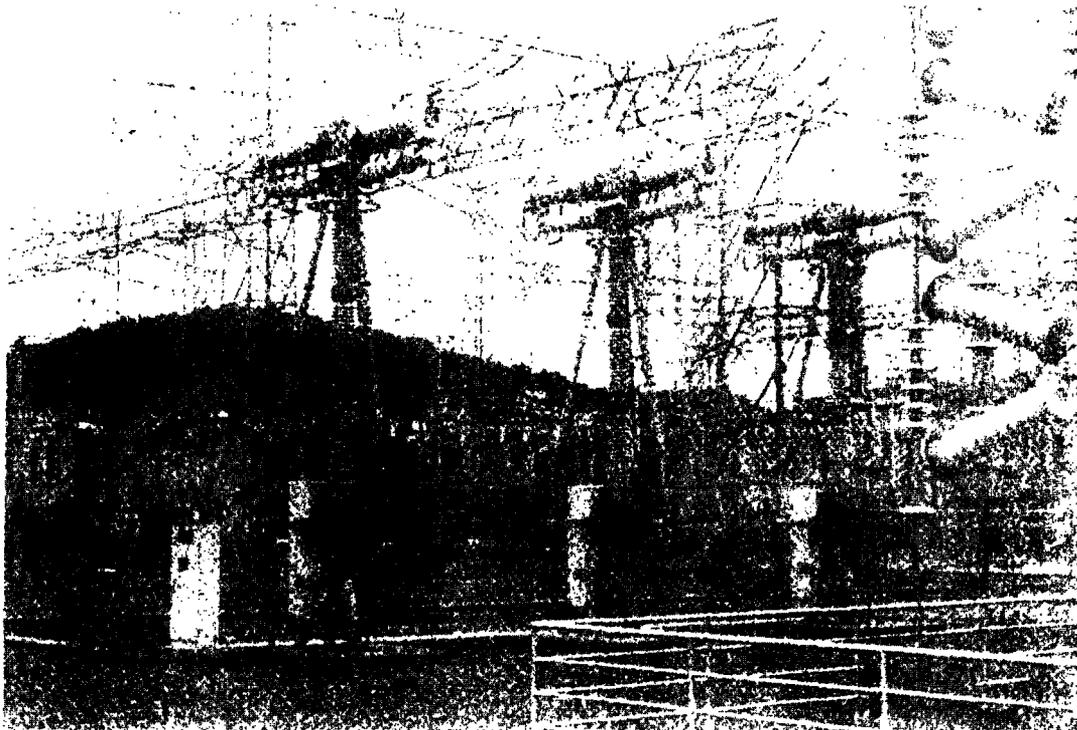


Figure 6.21 Sendai Substation, Izumi: a general view of a portion of one of the buses. Damage was not reported to these steel structures.

Figure 6.22 Sendai Substation, Izumi: three replaced 3-phase circuit breakers. This type of T-shaped circuit breaker suffered a high percentage of damage. Often the three symmetrical guides broke before the main stem. In all cases the structural steel supports appeared to be undamaged.



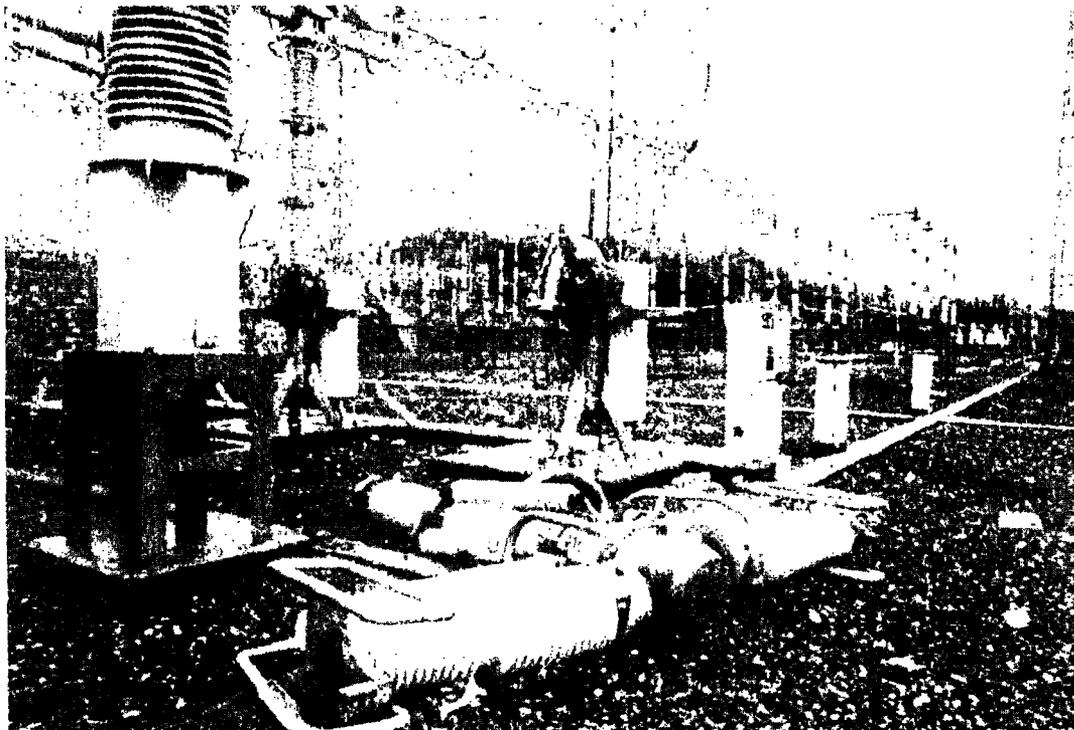
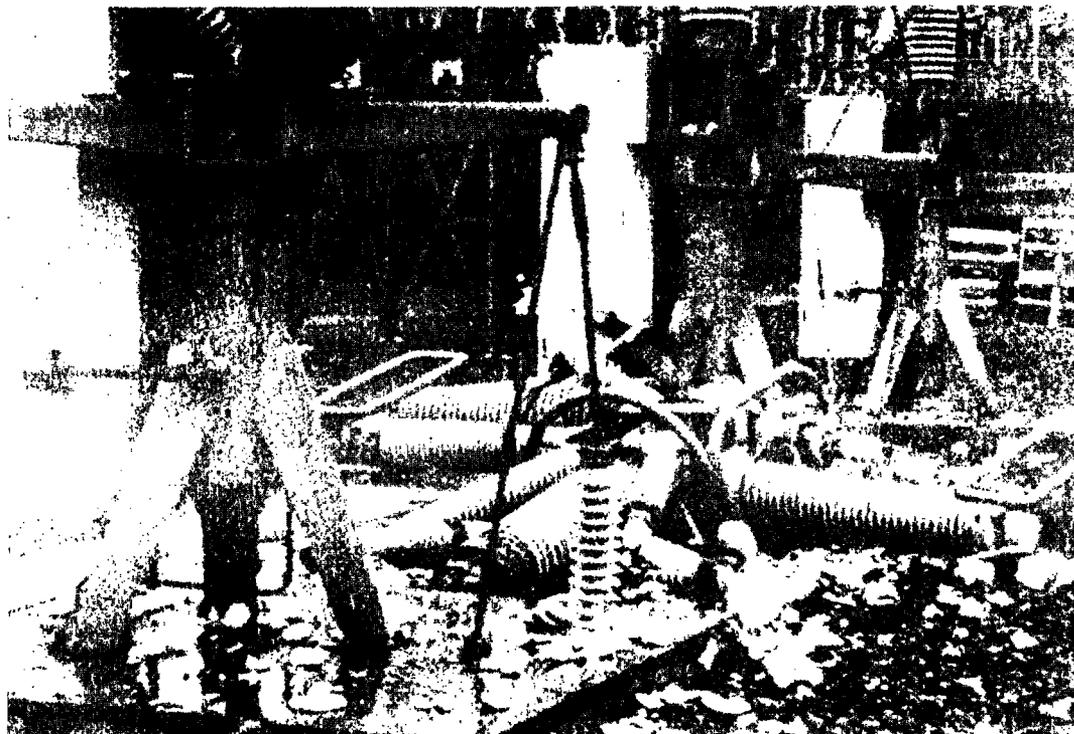


Figure 6.23 Sendai Substation, Izumi: typical damage to 3-phase T-shaped circuit breakers (as shown in previous figure). Note the complete failure of one and the damage to the three guides of the second circuit breaker. All steel supports appear to be undamaged. The photograph was taken immediately after the earthquake before repairs were initiated. (Tohoku Electric Power Co. photograph)

Figure 6.24 Sendai Substation, Izumi: another three failed 3-phase, T-shaped circuit breakers. Note the failed main stems, the loose guide wires and the undamaged steel supports which are attached to their foundations. (Tohoku Electric Power Co. photograph)



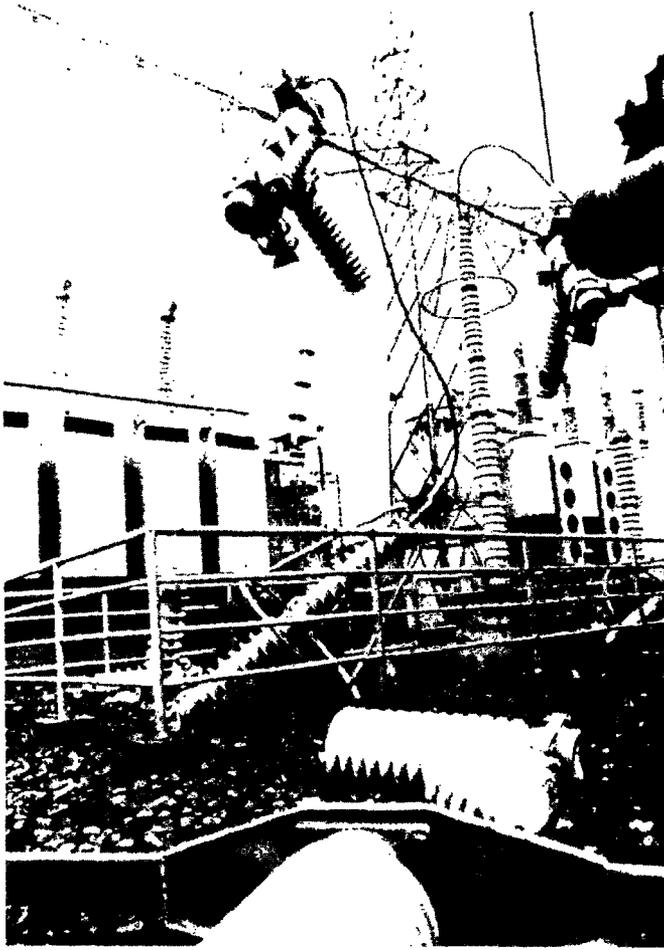


Figure 6.25 Sendai Substation, Izumi: damage to a circuit breaker (right), and two lightning arresters (center). The bushings of the transformer in the background appear to be undamaged; however, the lightning arrester is leaning. (Tohoku Electric Power Co. photograph)

Figure 6.26 Sendai Substation, Izumi: Severe damage to circuit breakers (center of photograph - note the failed columns of live tank design, probably with gas reservoirs), current transformers (with the tapered bushings - some of the stems are also damaged), and reactors (to the left) with presumably broken connections. (Tohoku Electric Power Co. photograph)



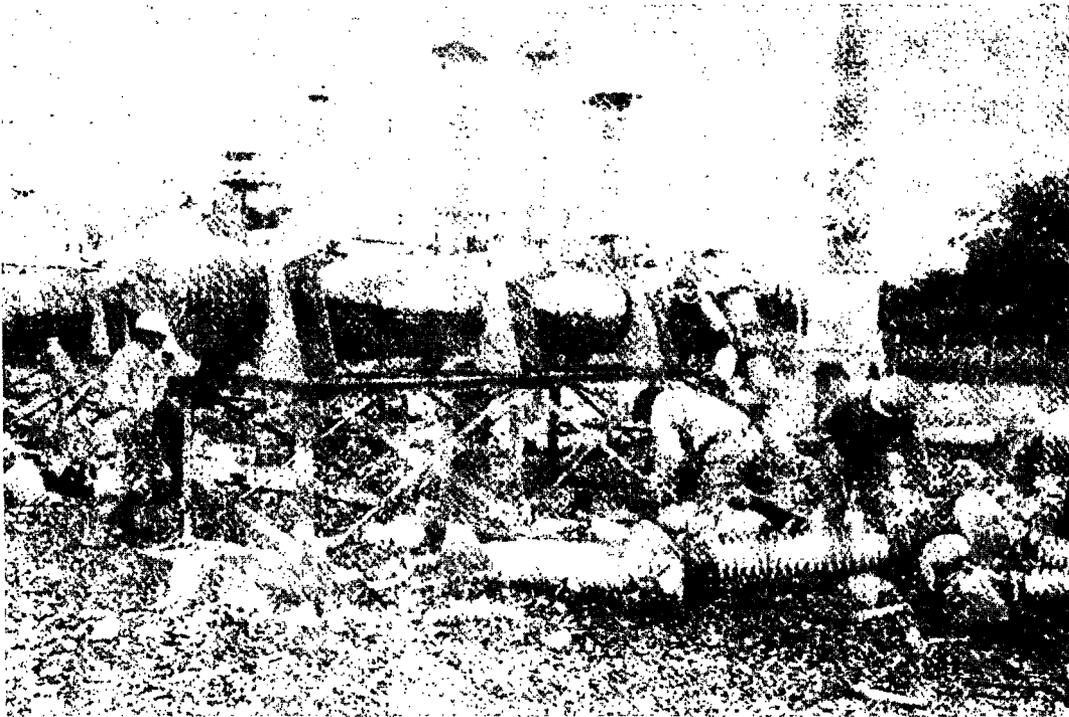
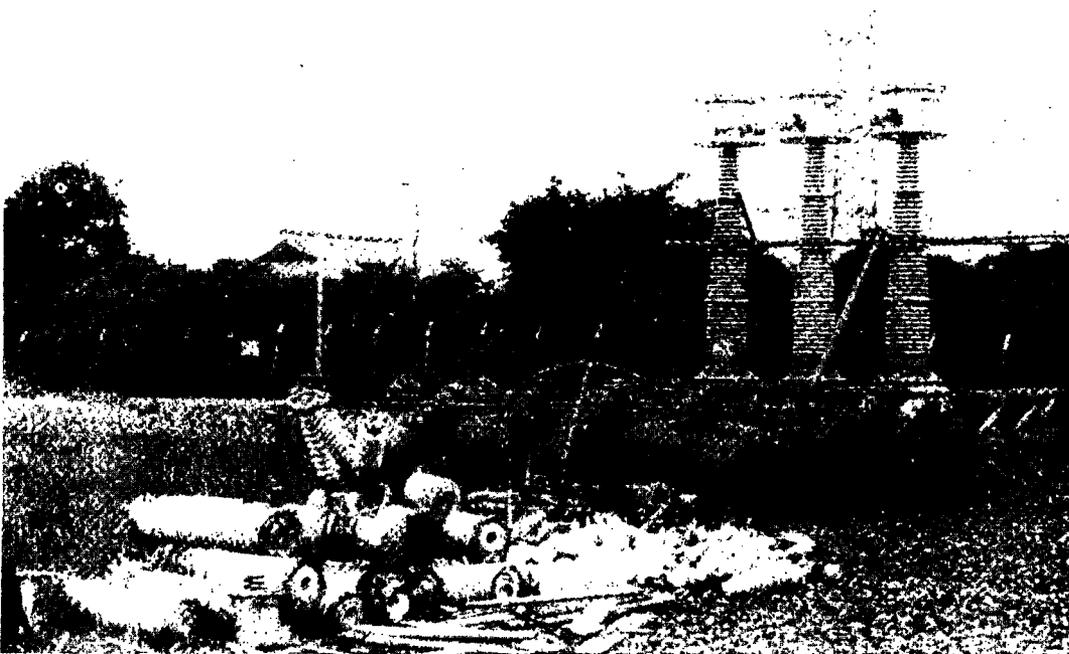


Figure 6.27 Sendai Substation, Izumi. Severe damage to several circuit breakers of live tank design. Note the lack of damage to the structural steel supports and the steel components of the equipment. (Tohoku Electric Power Co. photograph)

Figure 6.28 Sendai Substation, Izumi; one of several piles of broken equipment, including several line traps or reactors in the back (note the damaged base of the left stem) and the horizontal tanks of several circuit breakers of the live tank type (in the foreground are the failed columns of the circuit breakers and of other equipment).



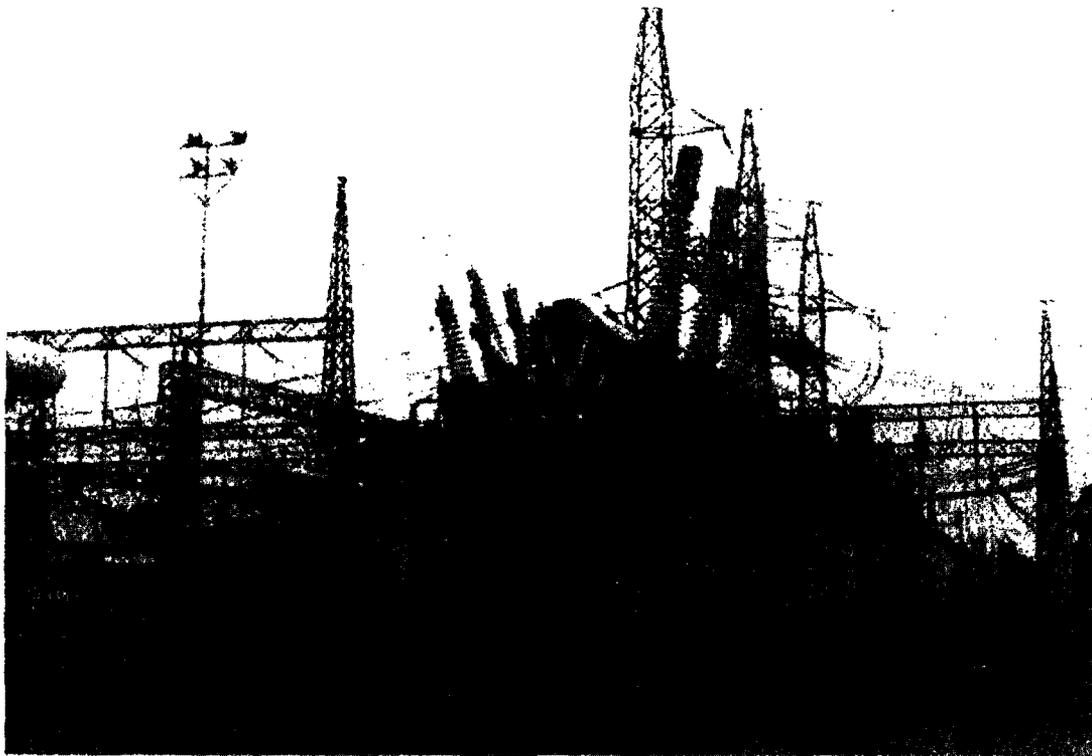
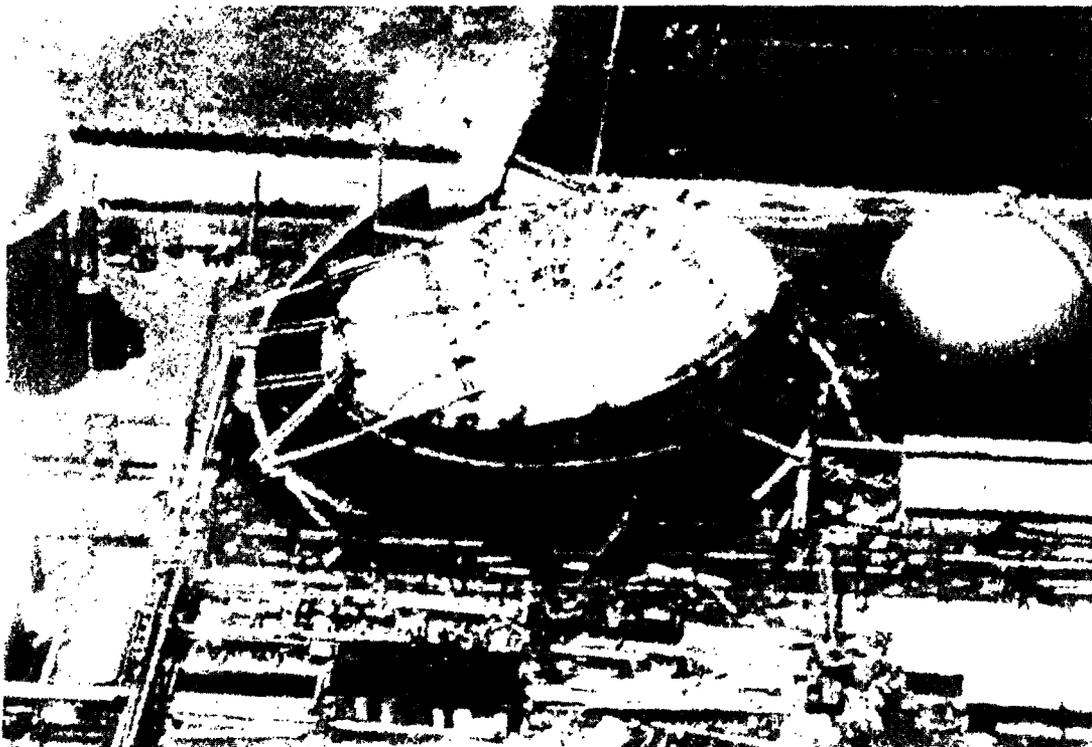


Figure 6.29 Sendai Substation, Izumi; a repaired but still disconnected transformer. All of the transformers at the substation lost some bushings or lightning arrestors. Some damaged parts were being replaced at the time of the investigation.

Figure 6.30 Haranomachi Plant, Sendai City Gas Bureau: an overall view of a collapsed propane gas holder and some of the surrounding propane storage tanks and affected pipeway and equipment. (Kahoku Newspaper Co. photograph)



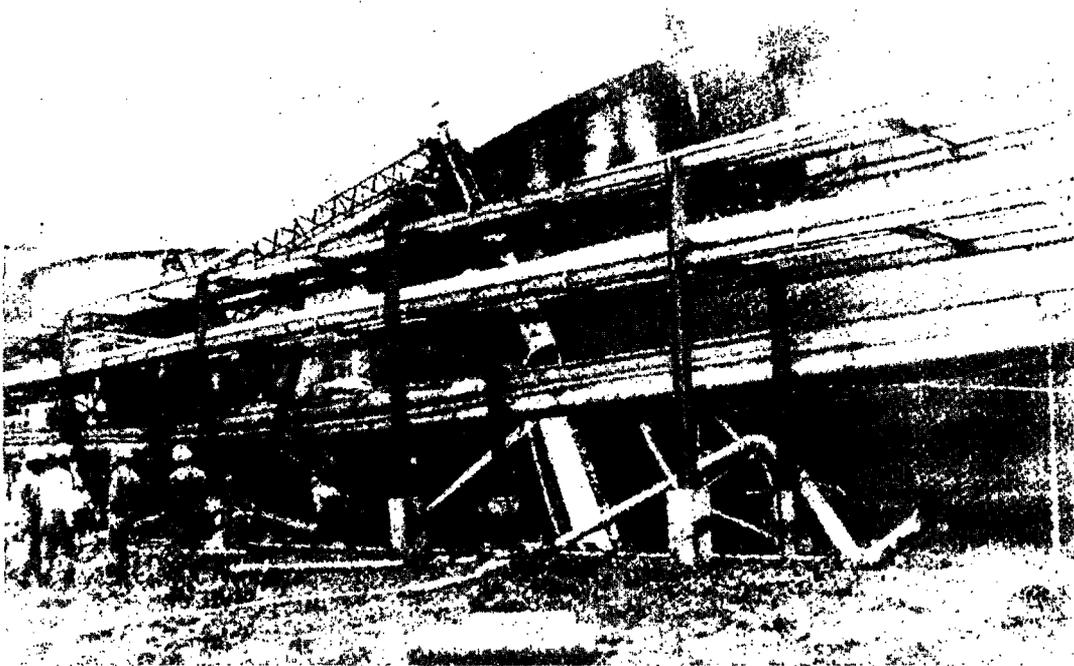
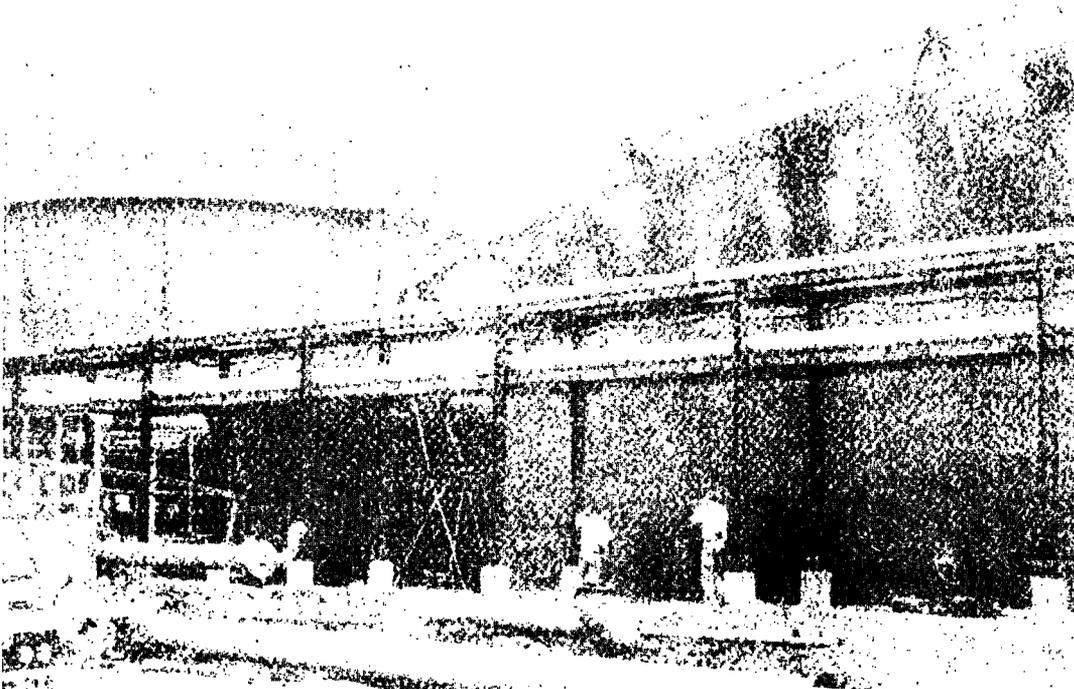


Figure 6.31 Haranomachi Plant, Sendai Gas Bureau; collapsed gas holder and the damaged adjacent pipeway structure just after the earthquake, (Sendai Gas Bureau Photograph)

Figure 6.32 Haranomachi Plant, Sendai City Gas Bureau: The newly erected pipeway, with the collapsed holder in the background. Note the undamaged pressurized propene gas sphere in the back.



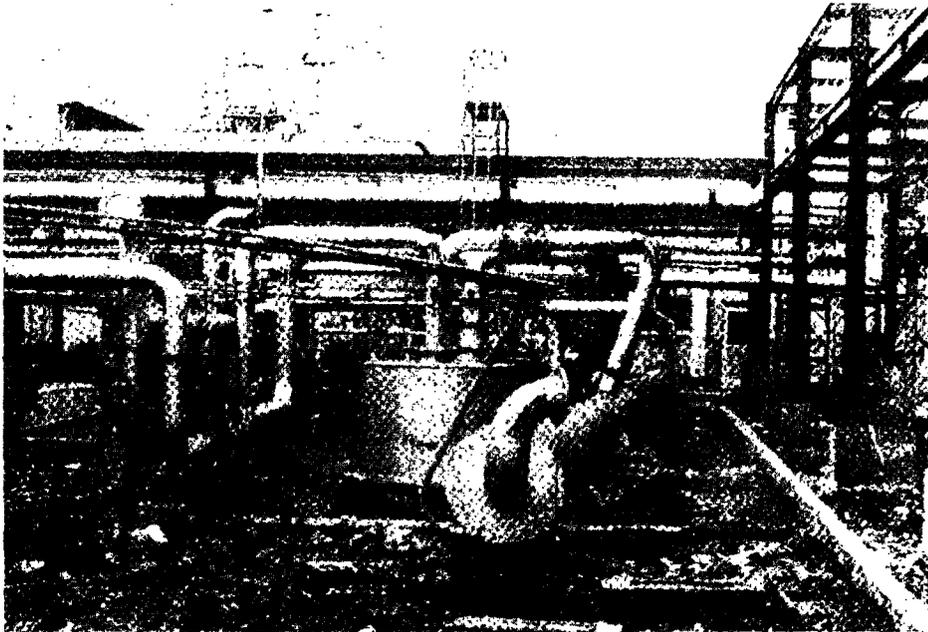


Figure 6.33 Haranomachi Plant, Sendai City Gas Bureau: damage to piping and other equipment and supports caused by impact from the collapsed gas holder and the adjacent pipeway. The newly erected pipeway is to the right.

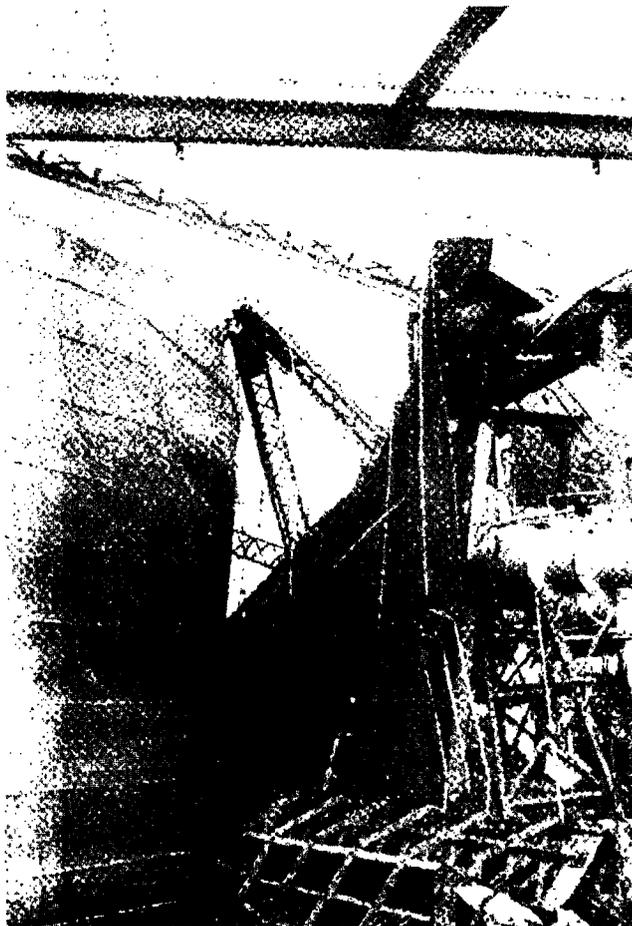


Figure 6.34 Haranomachi Plant, Sendai City Gas Bureau: damage to the telescoping gas holder and to some of the nearby pipeways and equipment. The trusses are portions of the original support structure that had surrounded the tank.

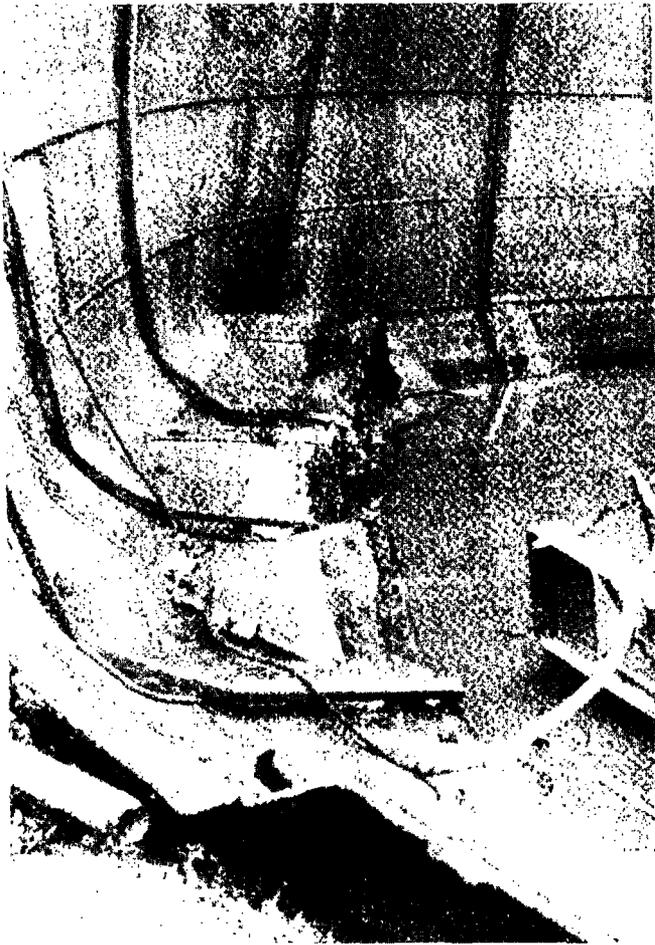


Figure 6.35 Haranomachi Plant, Sendai City Gas Bureau: buckling damage to the lower portion of one segment of the gas holder.

Figure 6.36 Haranomachi Plant, Sendai City Gas Bureau: a fracture of the 3/8-in. plate wall of the collapsed gas holder. The length of the fracture is approximately 1.5 m (5 ft).



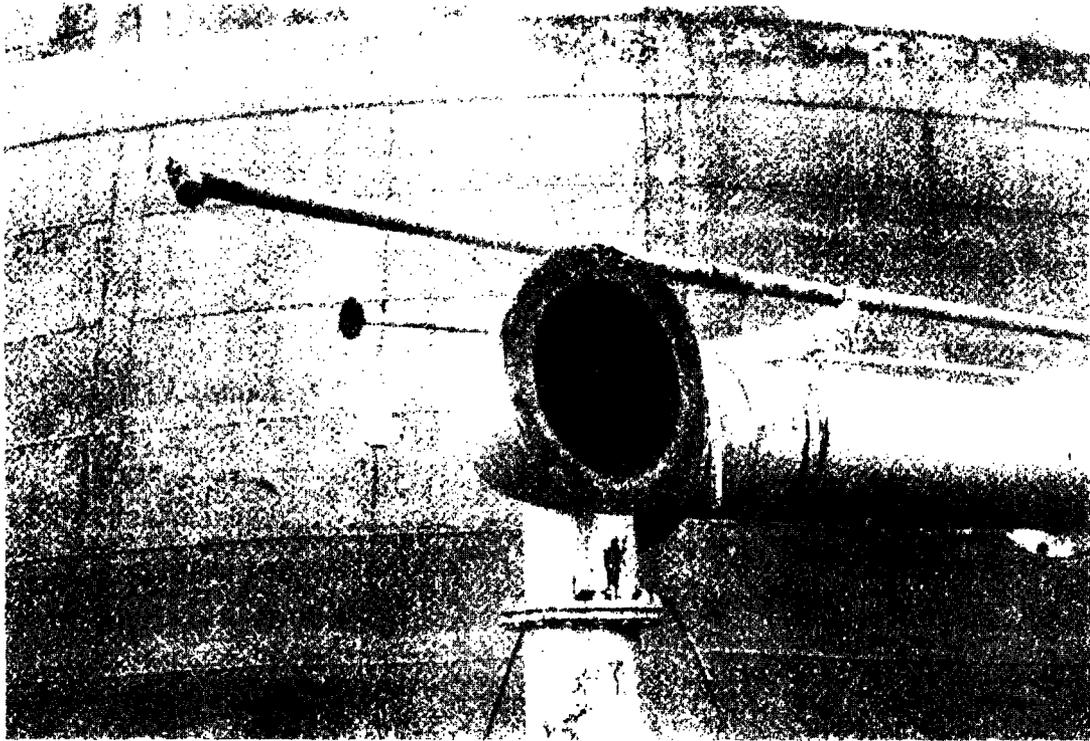
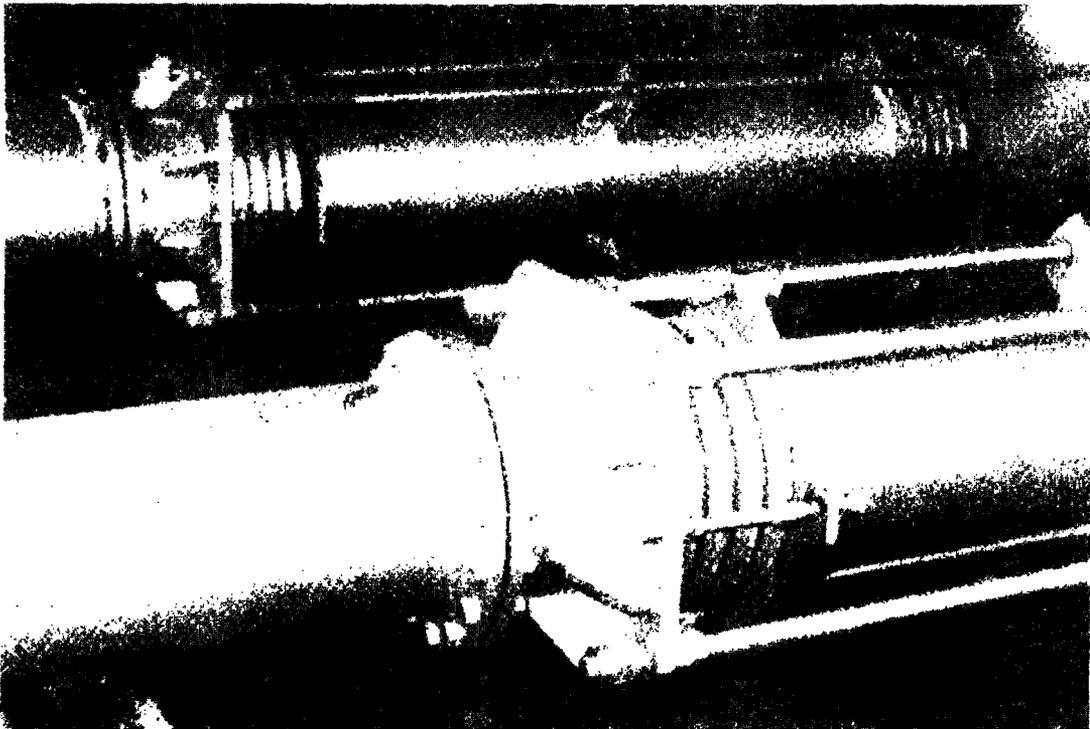


Figure 6.37 Haranomachi Plant, Sendai City Gas Bureau: sheared pipe flange connections in the pipeway structure in the vicinity of the collapsed gas holder.

Figure 6.38 Haranomachi Plant, Sendai City Gas Bureau: undamaged expansion bellows that moved several inches during the earthquake.



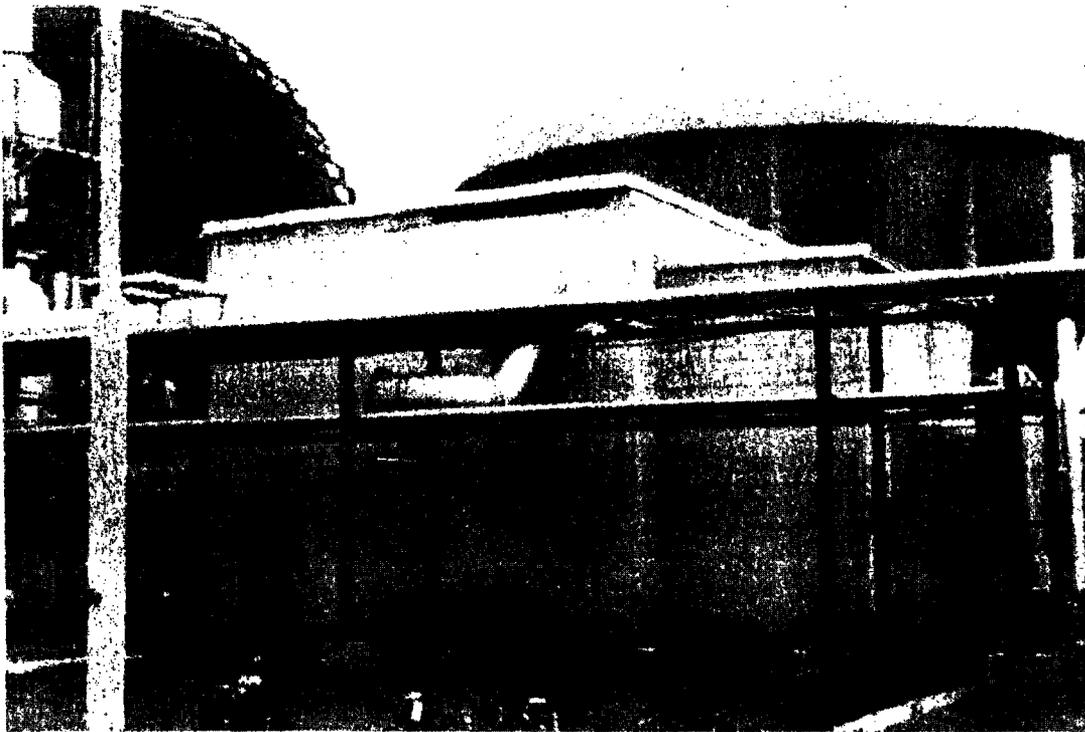
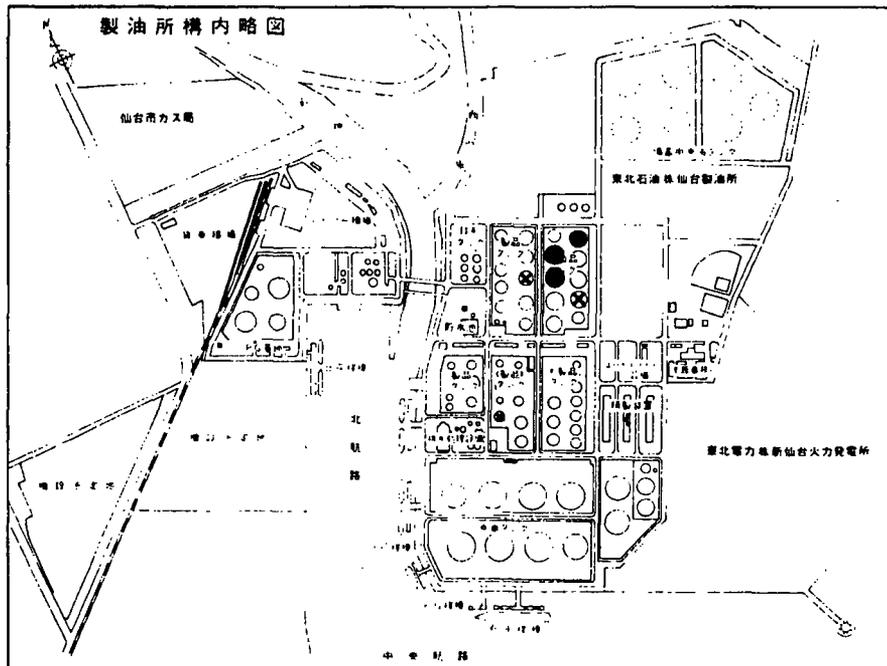


Figure 6.39 Haranomachi Plant, Sendai City Gas Bureau: a damaged reinforced concrete block structure. Some of the damage was due to pounding between the large diameter pipe and the structure at the pipe penetration.

Figure 6.40 Plan of the Sendai Refinery, Tohoku Oil Company, Ltd. Tanks are shown as circles in the plan. The circles that represent the three failed TC tanks have been blackened; ones that represent the three other damaged tanks are marked with an X. The refinery structures are located to the right of the tank farms.



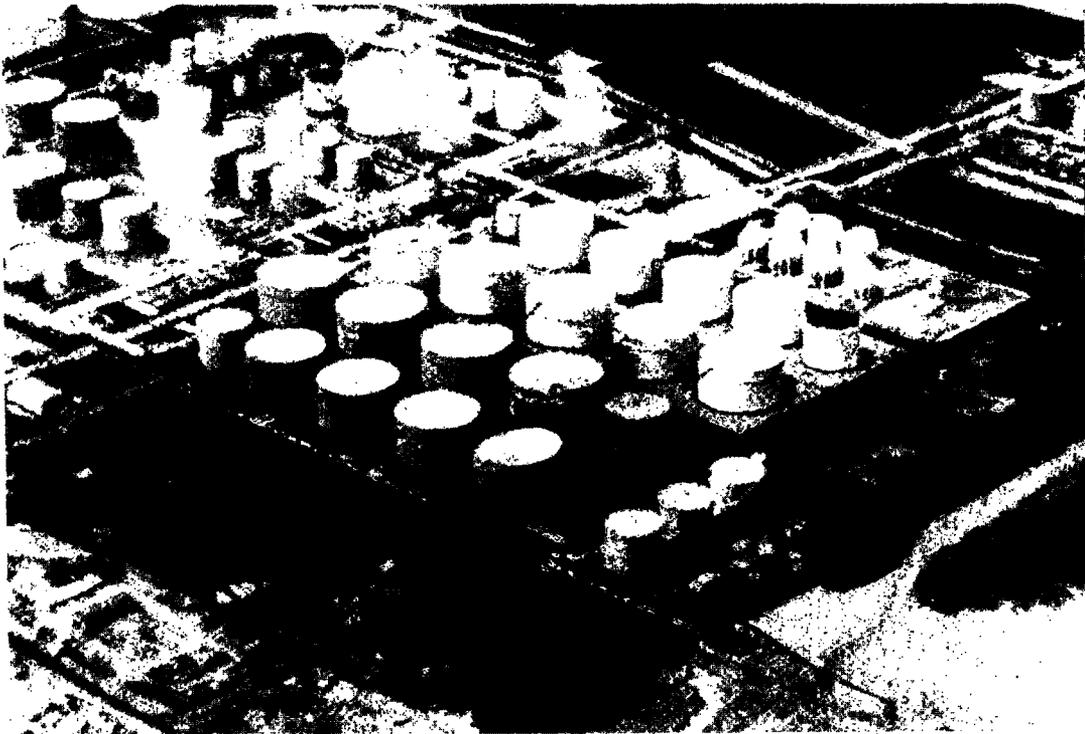


Figure 6.41 Sendai Refinery, Tohoku Oil Company, Ltd.: an overall view of the refinery's tank farm. The spilled oil appears as the dark area of the photograph. (Tohoku Oil Company photograph)

Figure 6.42 Sendai Refinery, Tohoku Oil Company, Ltd.: one of the three failed storage tanks. The damage illustrated is due to suction caused by rapid evacuation of the oil through the ruptured connection of the base and wall of the tank. The several tanks, of similar size, in the foreground are thought to be undamaged.

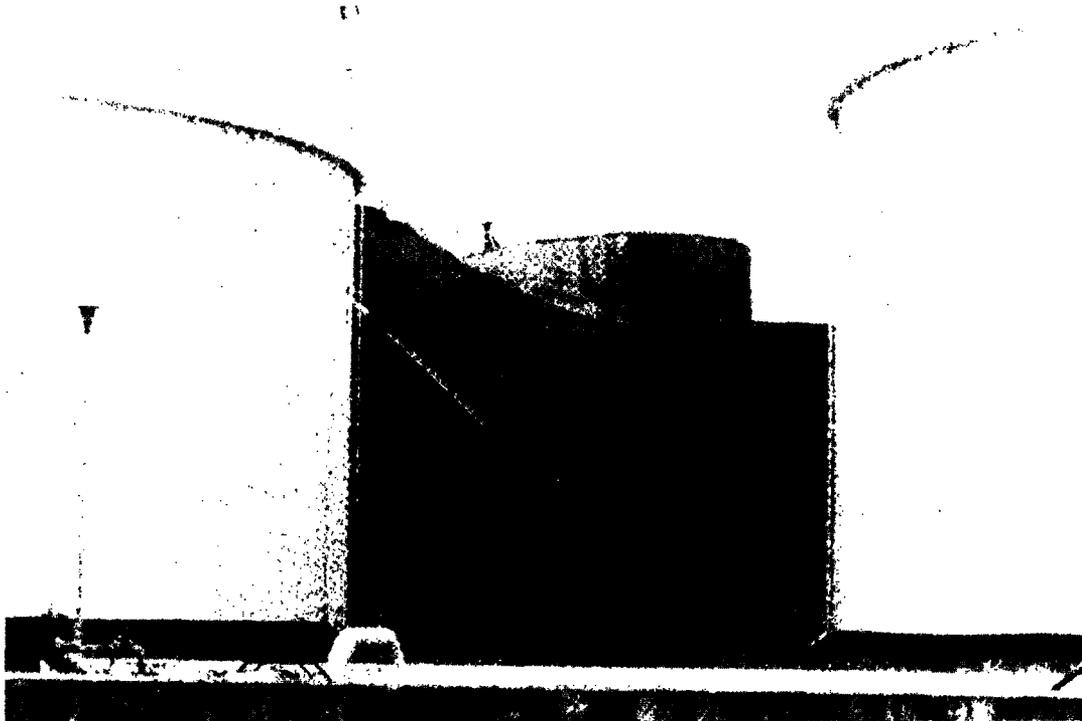




Figure 6.43 Sendai Refinery, Tohoku Oil Company, Ltd. Two other failed TC oil storage tanks.

Figure 6.44 Sendai Refinery, Tohoku Oil Company, Ltd. TC oil storage tanks.



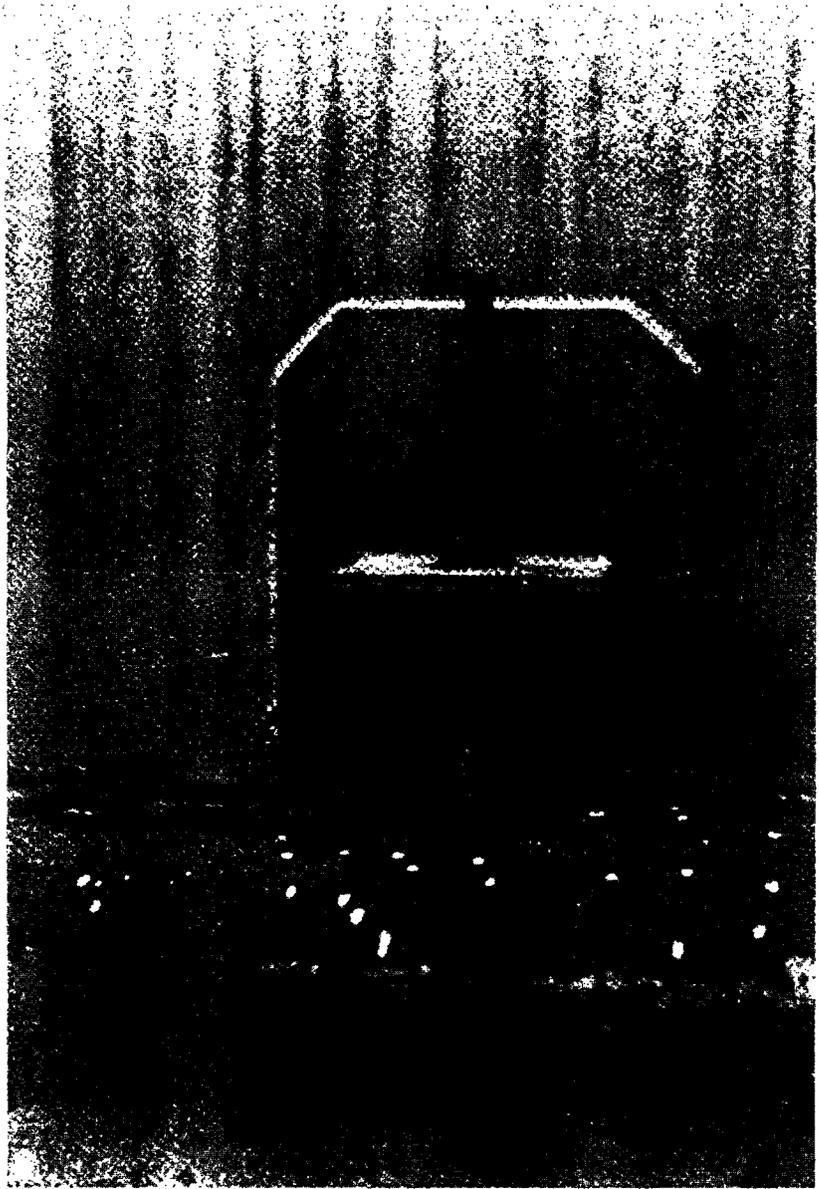
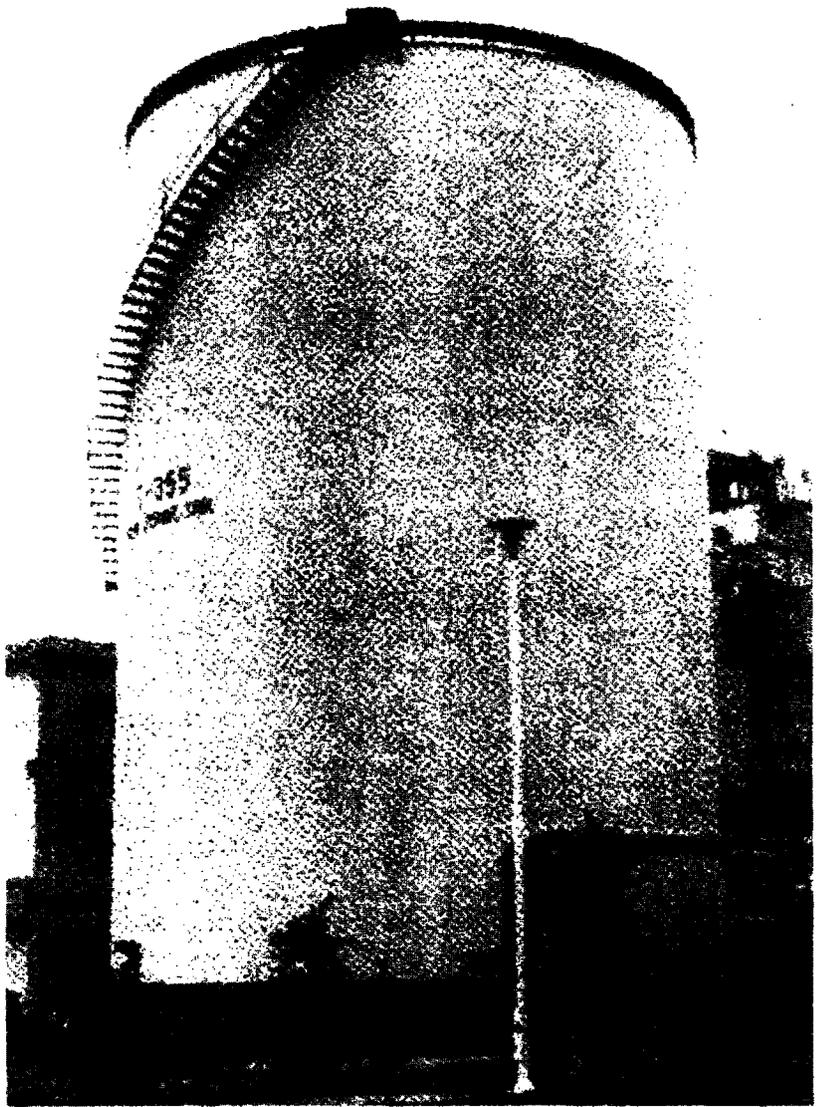


Figure 6.45 Sendai Refinery, Tohoku Oil Company, Ltd. A large water storage tank (left) near the main refinery complex appeared to have experienced significant rocking. Detail (right) of one of the pulled-out, or stretched, anchor bolts of the water storage tanks shown at left.

Figure 6.46 Sendai Refinery, Tohoku Oil Company, Ltd.: an undamaged LPG storage tank. Note the heavy diagonal bracing in the supporting structure.

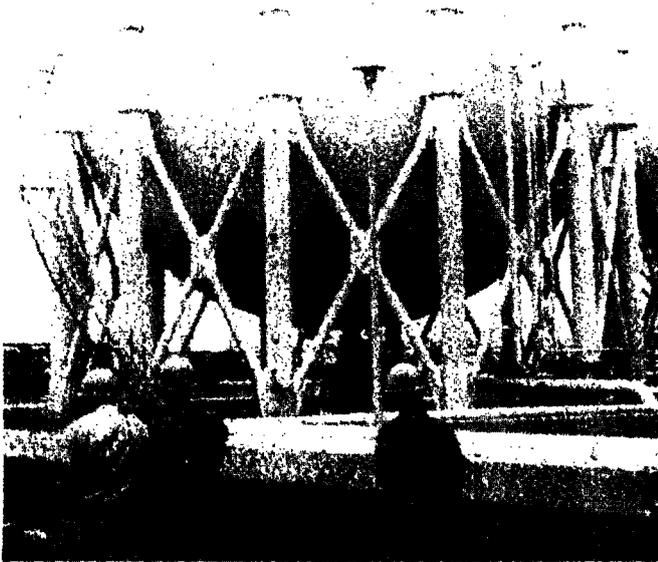


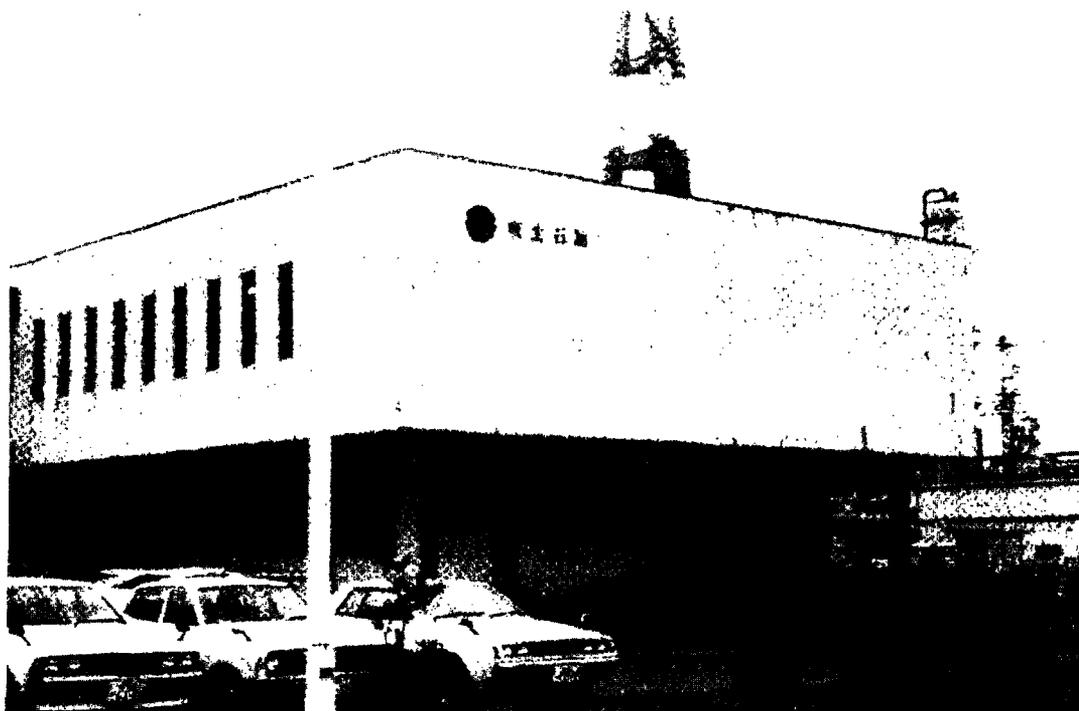
Figure 6.47 Sendai Refinery, Tohoku Oil Company, Ltd.: a partial view of the refinery.





Figure 6.48 Sendai Refinery, Tohoku Oil Company, Ltd.: ground settlement at the refinery.

Figure 6.49 Sendai Refinery, Tohoku Oil Company, Ltd.: A wing of the damaged steel-framed administration building. Damage was obvious only to the architectural finishes.



As illustrated in Figure 6.40, the complex is divided in two parts by a river and some port facilities. The new Sendai Power Plant is to the east (right). The tank farms and the refinery complex itself are located on the eastern portion, adjacent to the port facilities, which can handle super tankers. The gas producing and pumping facilities are located on the western half of the complex. The land transportation facilities are also located on the west side.

The damage of the refinery and the lost oil represent one of the major losses from the Miyagi-ken-oki earthquake. At the time of the investigation (June 24, 12 days after the earthquake) the total amount of damage was unknown, as investigations were still continuing. It was expected that the damage investigations and evaluations by the company and the local fire authorities would continue well into July. The reported intensity at the site was 5 on the JMA scale, and the epicentral distance is approximately 100 km. The adjacent power plant had an accelerometer, which did not operate, and a seismic alarm, located at the turbine building operating floor, which was triggered by the earthquake. As the alarm was set at approximately 0.15 g, the motion was probably in excess of 0.15 g. In all probability, the motion exceeded 0.25 g.

The investigation revealed that the complex had been designed to reasonable seismic criteria. All of the observed tanks, equipment and piping systems were anchored and no overturning failures were observed. As discussed further, some of the tanks were designed for a 0.30 g peak ground acceleration. Major portions of the facility were located on engineered fill. There was some evidence of settlement, however it could not be determined if the settlement had occurred in filled areas.

There are at least 87 storage tanks in the facility. The tanks have different designs, and different functions; some stored oil, others stored liquid propane gas (LPG); some had fixed roofs, others had movable roofs. Three large tanks containing refined fuel called Top Crude (TC) failed, spilling approximately 68,100 kl of oil. The capacity of the tanks was 85,000 kl. The surrounding reinforced concrete dike could accommodate only 35,000 kl. The oil overtopped the dike, inundated much of the refinery area, and spilled over into the port (Figure 6.41). Because the surface soils are sandy, it is believed that much of the oil that was contained in the dike subsequently leaked under the walls and contributed to the spill.

At the time of the investigation a thick film of oil still covered much of the refinery grounds. Thus, the fire hazard was great, and the investigating team was unable to observe the details of the damage to the tanks. It is believed that the tanks shown in Figures 6.42 through 6.44 failed at their bases. The oil drained rapidly, causing a vacuum inside, which imploded the tanks. Three other tanks suffered damage and will need repair.

Another large water storage tank experienced interesting damage (Figure 6.45). The welded steel plate tank was anchored with bolts, spaced at approximately 6 ft (2 m), and embedded in a continuous concrete pad. The bolts around the entire circumference were stretched, or more likely, pulled out from their embedment from 1 to 6 in (2.5 to 15 cm). However, there was no apparent buckling or other damage to the steel base of the tank.

Visual inspection of several of the LPG tanks at the refinery, revealed no damage. There were minor cracks in the concrete supports and some spalling of paint in the steel connections due to working. The tanks were designed for 0.30g peak ground acceleration. As illustrated in Figure 6.46, the tanks were heavily braced with diagonal braces with circular cross-sections.

Figure 6.47 shows a partial view of the refinery, including several towers, heaters, boilers and a heavily braced steel stack. These structures are reportedly undamaged. The team was able to view some of the lower structures; no structural damage was observed. At the time of the reconnaissance, most of the equipment within the refinery complex had not yet been checked for operability. There was concern that some of the control equipment, and other minor operating equipment might have been damaged. Local settlements may have damaged some equipment, as illustrated in Figure 6.48. The pipeway support structures that were examined showed no significant damage.

Most of the refinery was shut down during the earthquake for its annual inspection. Thus a serious fire hazard from the spilled oil fortuitously was averted. During the investigation, the company was checking much of the equipment throughout the complex for damage, and a large scale clean-up effort was under way. The seriously damaged tanks were still not approachable because of the spilled oil.

6.7 Concrete Batch Plant, Sendai

This concrete batch plant is probably a representative small facility for the many thousands of similar (in size) industrial or manufacturing establishments in the metropolitan area of Sendai. It was operating at the time of the investigation. The facility sustained various types of structural damage to equipment and tank supports, buckling of storage tank walls, damage to structural steel framing, etc. It is very possible that this damage (and damage to similar small facilities), was not reported and is not included in the preliminary damage statistics that were available to the UJNR team members. The plant was inoperable for two days after the earthquake while repairs were being carried out. Because most of the damage was to structural steel braces, it apparently was easily repairable. In many cases the bolted connections of the braces to the vertical load carrying supports were sheared. Repairs were usually of two types: (1) the undamaged braces were realigned and the braces were welded to the gusset plates (in lieu of the previous bolting) and (2) damaged (presumably buckled) braces were replaced with new members, which were also welded in place (Figures 6.50 and 6.51). The most remarkable feature of the repairs was how quickly the work was completed, particularly at a time when skilled labor was presumably in short supply. Some serious structural damage had not yet been corrected at the time of the investigation; however, that damage was not to operating equipment and did not affect the day-to-day production. Except for some of the foundations and lower supporting structures, which were not damaged, all of the structures, tanks, and equipment at the site are made of steel.

A large welded steel plate storage tank, containing sand and gravel, and reportedly full during the earthquake, which was supported on a massive concrete pedestal, suffered buckling along several locations at the base of the steel plate (Figures 6.52 and 6.53). It seems apparent that the buckling was caused by overturning forces, rather than by sloshing of the contents. The tank and its superstructure and support structure did not experience any other damage.

One of the light steel-framed structures at the plant was damaged, as shown in Figure 6.54, apparently because of inadequate lateral bracing. The differential displacement caused by the failure of the structure was responsible for damage to a connecting vertical steel stack and associated piping. The stiffer first floor reinforced concrete structure was undamaged. A similar structure, Figure 6.55, located in the immediate vicinity of the plant and properly braced with light steel cable or rod braces, did not suffer damage. The latter type of construction is quite common in Sendai, and generally appeared to experience no significant damage.

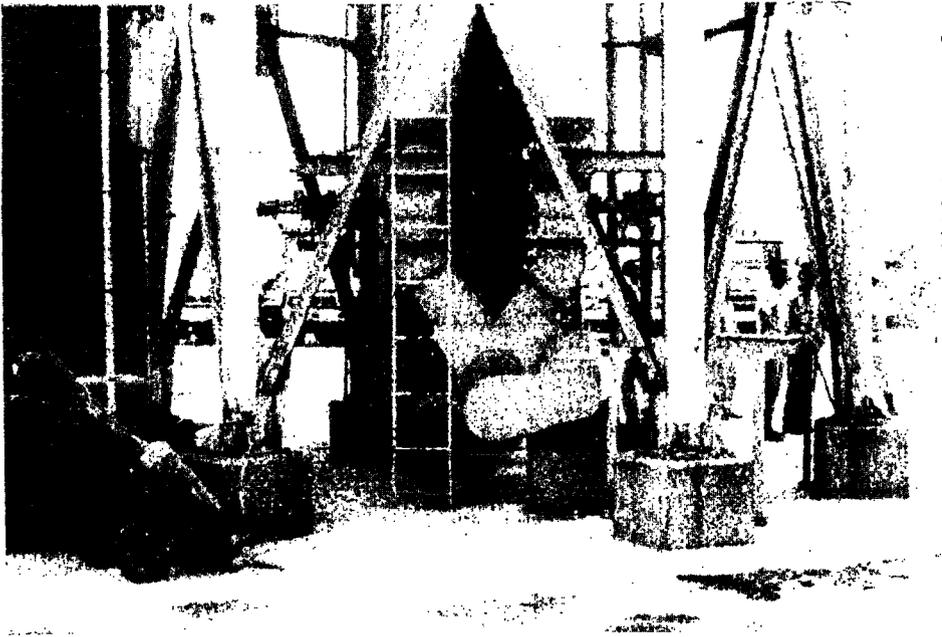


Figure 6.50 Concrete Batch Plant, Sendai: view of the repaired supporting substructure of a cement bin and related equipment. The sheared bolts at the brace connections have been removed and the braces have been welded to the gusset plates. Some of the buckled braces have been replaced entirely.

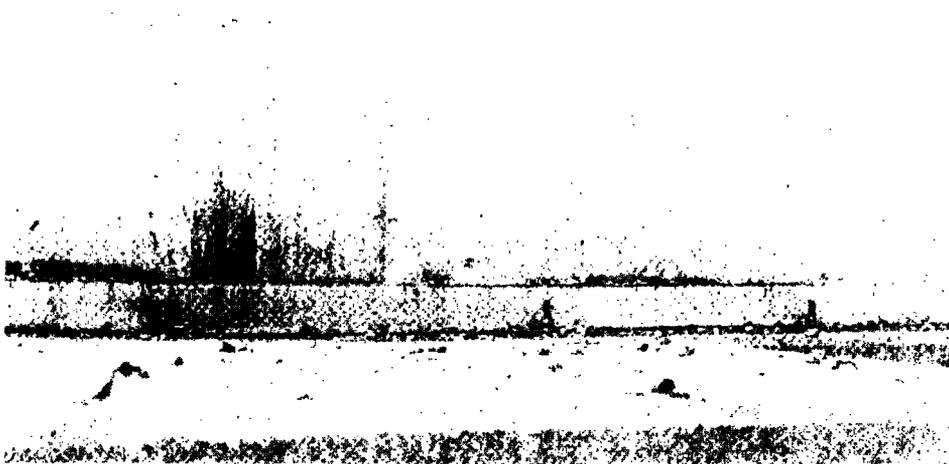


Figure 6.51 Concrete Batch Plant, Sendai: a detail of a replaced, and presumably buckled, diagonal brace. A number of similar repairs were carried out within two days after the earthquake.

Figure 6.52 Concrete Batch Plant, Sendai:
a large gravel-and-sand-
storage tank experienced
buckling of the welded steel
plate at its base.



Figure 6.53 Concrete Batch Plant, Sendai: a detailed view of the
damaged base of the sand and gravel storage tank.
Note the closely spaced anchor bolts. Similar damage
occurred at several locations along the circumference.



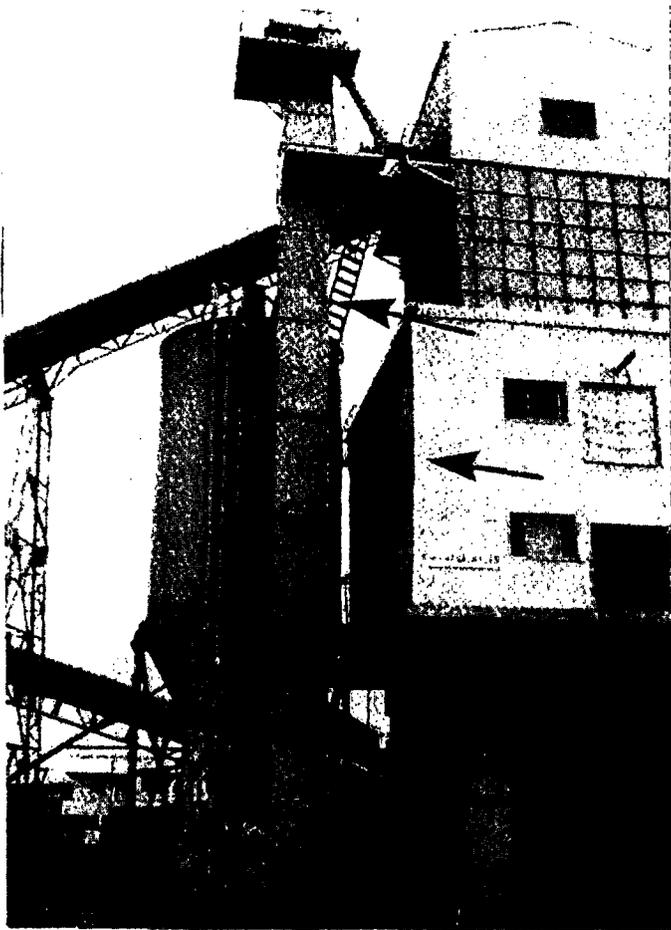
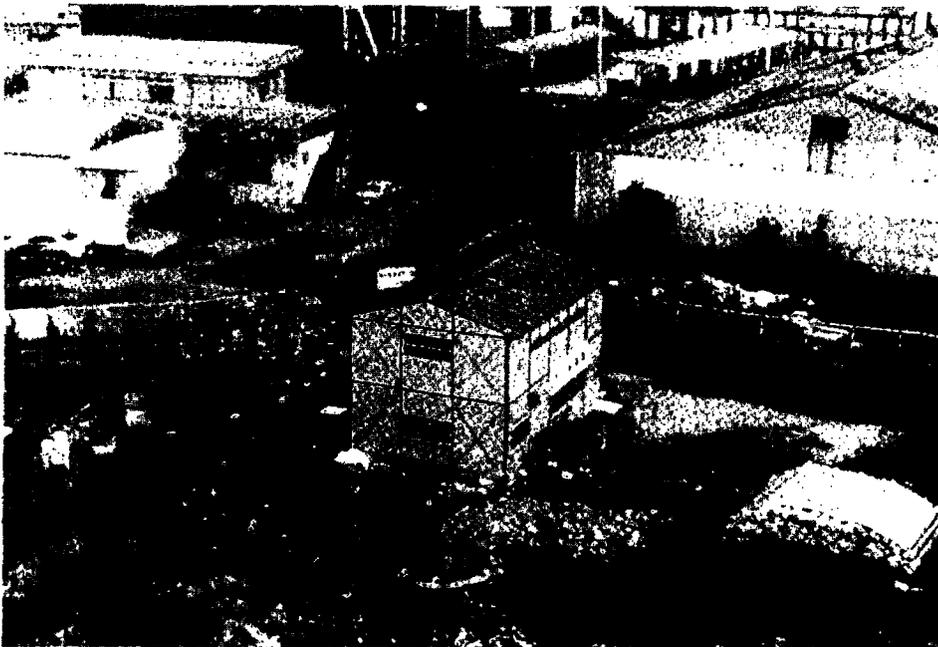


Figure 6.54 Concrete Batch Plant, Sendai: displacement due to damage to the light, unbraced steel superstructure damaged the vertical stack and the conveyor belt structure.

Figure 6.55 Concrete Batch Plant, Sendai: a typical undamaged light steel-framed structure braced with cable or rod braces.



7. EARTHQUAKE PERFORMANCE OF TRANSPORTATION LIFELINES*

7.1 INTRODUCTION

The Japanese Ministry of Construction (JMOC) reported that 78 highway bridges had been damaged as a result of the June 12, 1978, Miyagi-ken-oki earthquake. There were, however, no reports of damage to a multitude of pedestrian bridges in Miyagi prefecture. Only those bridges having an estimated repair cost of 1 million yen (\$5,000) or more were included in an inventory of damaged highway structures. Although damage to bridges was principally confined to those structures within Miyagi prefecture, some bridges sustained moderate damage in Iwate and Fukushima Prefectures also. Of approximately 100 bridges in Sendai, only four were reported as having been damaged. Two of those bridges were inspected by UJNR team members. The majority of damaged bridges were located in an area extending about 90 kilometers northeast of Sendai (see Table 5.1 and Figures 5.3 and 6.1).

The UJNR inspection team visited 13 highway bridge and four rail bridge sites, viewing representative damage. Typical types of damage included flexural and torsional cracking of concrete piers, displaced or dislodged girder bearing devices, settlements of abutments or piers, and vibratory induced settlements of fills at bridge approaches.

Significant strong motion records were obtained from the Kaihoku Bridge, 65 km northeast of Sendai and the Date Bridge about 75 km southwest of Sendai (just north of Fukushima City). Only the Kaihoku Bridge site was visited by UJNR team members. Maximum ground acceleration at Kaihoku was 294 gal, while maximum pier acceleration was greater than 500 gal. No ground record was obtained from the Date Bridge site. Maximum pier acceleration was 475 gal.

The Japanese National Railways stopped all trains following the earthquake until safety inspections could be made. Most damage was caused by blockage of track, by landsliding, and most train service was restored within 3 days following the earthquake. Heavy pier damage occurred at a rail bridge site which required 10 days to reopen.

There was no reported damage to highway tunnels in Miyagi prefecture. Only one railway tunnel on the New Sendai Shinkansen Line (fast train) northeast of Sendai was reported to have suffered minor, hairline cracks in its concrete lining.

The public bus system in Sendai was not adversely affected by the earthquake.

It is reported that airline traffic to and from Sendai was interrupted only briefly while a quick inspection of the airport was made by airport officials. Minor damage of the terminal was reported.

No major damage was reported at Shiogama Port 18 km northeast of Sendai. Some pavement settlement was noted. One free field strong motion record obtained from a SMAC B2 instrument at Shiogama Port recorded maximum accelerations of 266 gal in the N-S direction, 288 gal in the E-W direction, and 166 gal vertical component. For further discussion of strong motion records, see Chapter 4 of this report.

7.2 BRIDGE DESIGN CRITERIA

A comparison of current (1978) seismic bridge design criteria used in the United States and in Japan is presented prior to the documentation of bridge damage.

The bridges which were damaged in the June 12 earthquake in Japan were designed and constructed using pre-1971 design criteria. Most of the damaged bridges are two-lane structures, situated in rural areas northeast of Sendai. The most noticeable difference in the construction of bridges is the use of massive substructure elements. Most Japanese bridge piers are very large, massive appearing structures which are designed to resist seismic forces. Substructures in the United States are designed for lower seismic force levels and rely on ductile behavior of columns.

* Prepared by James D. Cooper, Federal Highway Administration Washington, D.C.

For purposes of comparing current U.S. and Japanese seismic design criteria the 1977 American Association of State Highway and Transportation Officials (AASHTO) and the 1971 Japan Road Association (JRA), "Specifications for the Earthquake-Resistant Design of Highway Bridges" are considered (see Refs. 7.1 and 7.2). The 1977 AASHTO criteria is an adaptation of the criteria developed by the California Department of Transportation in 1973. The 1971 JRA criteria superseded provisions found in several different Japanese bridge codes, and were established in order to give a common basis for the seismic design of bridges. They emphasize the method of evaluating seismic forces, the basic principles to be exercised for testing site soil conditions, and general provisions to be observed in structural detailing.

Both criteria allow for the use of three alternate approaches for determining design earthquake force levels. The most commonly used is the equivalent static force method. For more complex bridges, either a response spectrum analysis or full dynamic analysis can be performed. The more common, equivalent static force method used by both countries is compared.

Table 7.1 summarizes the 1977 AASHTO and 1971 JRA criteria.

The approach is similar in that the lateral force design coefficient is comprised of factors relating to location (A and $v_1 \cdot k_0$), soil conditions (S and v_2), and structure response (R/Z , F , and β). In addition, the JRA criteria incorporates an importance factor, v_3 . The vertical seismic force is generally not considered in either criteria, except in the JRA criteria for the design of bearings at the connection of the super and substructures. The vertical design seismic coefficient of $k_v = 0.1$ is used.

Use of either criteria requires the computation of the fundamental period of the bridge. The AASHTO criteria specifies the following formula to approximate the period (T) of the structure:

$$T = 0.32 \sqrt{W/P}$$

which W is the dead load and P is the total uniform force required to cause a 1-inch maximum horizontal deflection of the total bridge. The JRA presents several alternate equations for use in estimating the period of the bridge which are dependent on the type of structural system, type of foundation, material of the pier, and direction of motion. The methods used to calculate period give slightly varying values which, when used in conjunction with a design spectra, give greatly varying values for design force levels.

For purposes of comparing the AASHTO and JRA criteria, the lateral force design coefficients are plotted in Figure 7.1. The comparison is made for a site having a depth of alluvium between 24 and 46 meters (80 and 150 feet), in a highly seismic area. For this condition, AASHTO requires $A = 0.5g$ and JRA requires $v_1 = 1.0$. Additionally, the JRA importance factor, v_3 , which is 1.0 for bridges on expressways, general national highways, and principal prefectural highways, etc., and 0.8 for all others, is assumed to be 1.0.

For the conditions assumed, the value of the JRA lateral force design coefficient (k_h) varies between 1.6 and 2.6 times the value given by the AASHTO criteria. The AASHTO criteria are applicable to structures having a period less than or equal to 3 seconds while the JRA criteria are applicable to structures having a natural period less than 5 seconds. The discontinuity of k_h at $T = 0.5$ is due to the increase of the modification factor (β) to reflect structural dynamic response and ground conditions. The larger JRA lateral force design coefficients would thus require the use of large substructure designs to resist earthquake forces when compared to designs using AASHTO criteria.

Seismic design criteria for highway bridges are currently (1979) under review by both the Japanese Ministry of Construction and the Federal Highway Administration. Both countries are in the process of revising requirements for determining seismic design force levels and structural details to provide improved resistance to earthquake induced ground motion.

7.3 BRIDGE DAMAGE

Significant bridge damage occurred during the June 12 earthquake. Given, however, the magnitude of the earthquake and the fact that most bridges damaged were pre-1960 vintage,

TABLE 7.1

Equivalent Static Force Method Code Comparison

Criteria	1975 AASHTO	1971 JRA
Lateral Force (EQ)	CFW	$k_h W$
Lateral Force Design Coefficient	$C = \frac{ARS}{Z}$ <p>Graphs of C as a function of bridge period and depth of alluvium are given where:</p> <p>A = max. expected to bedrock acceleration and related to 3 U.B.C. seismic zones.</p> <p>R = normalized rock response as a function of bridge period.</p> <p>S = soil amplification spectral ratio as a function of bridge period.</p> <p>Z = reduction factor for ductility and risk.</p>	$k_h = (v_1 v_2 v_3 k_0) \beta$ <p>$k = 0.2$</p> <p>β is a modification factor used when the bridge period is > 0.5 sec. and is a function of period and ground condition; where:</p> <p>v_1 = seismic zone factor.</p> <p>v_2 = soil factor based on depth of alluvium.</p> <p>v_3 = importance factor based on qualitative definition.</p> <p>k_0 = standard horizontal design seismic coefficient = 0.2.</p> <p>β = modification factor as a function of bridge period when period > 0.5 sec.</p>
Framing Factor	<p>F = 1.0 for single columns.</p> <p>F = 0.8 for continuous frames.</p>	None
Vertical Force Design Coeff.	None	$k_v = 0.1$ for design of bearing between sub and superstructure.
Design Force for Seismic Earth Pressure	No	Yes
Hydrodynamic Pressure During Earthquake	No	Yes

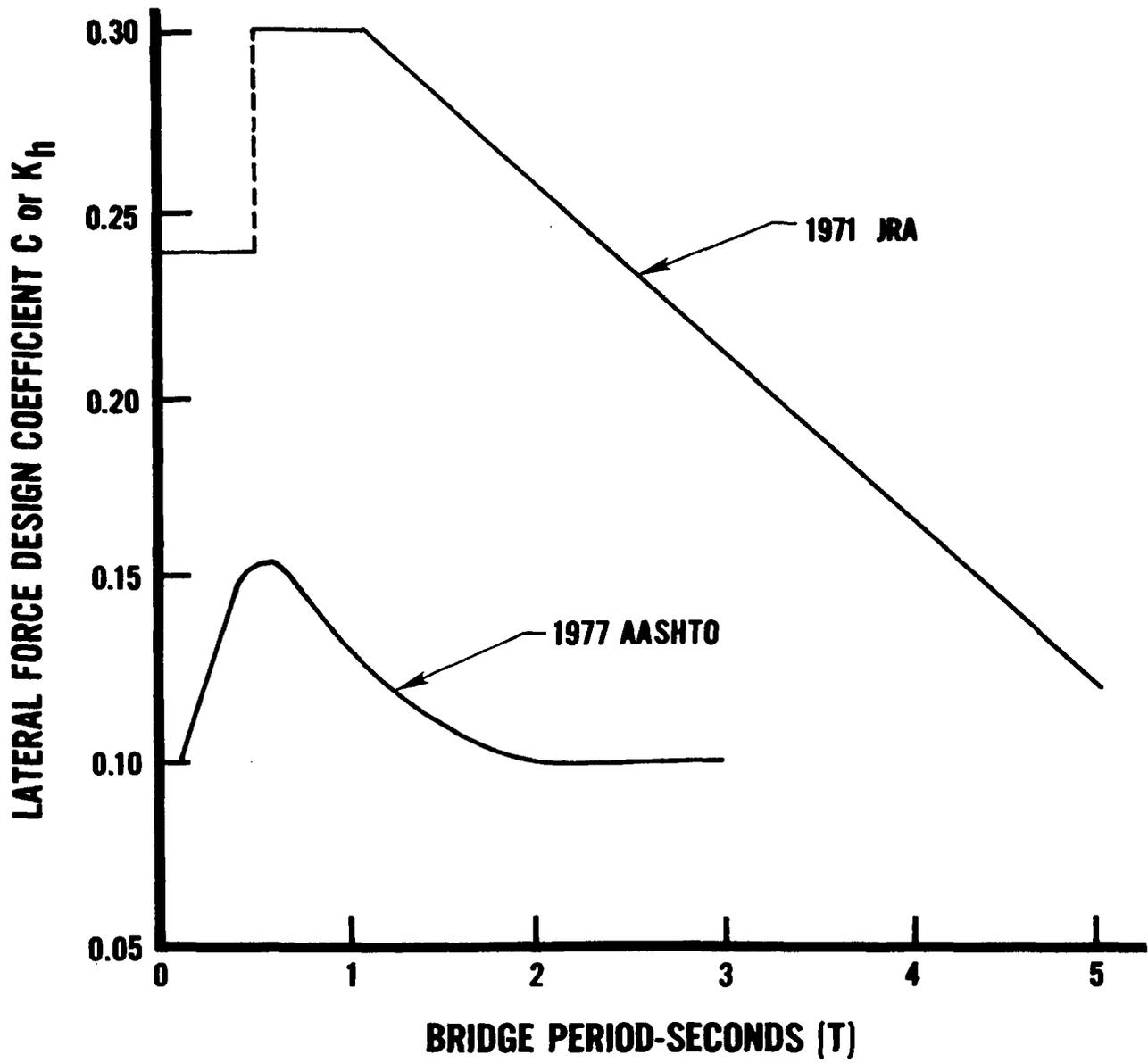


Figure 7.1 Comparison of AASHTO and JRA Lateral Force Design Coefficients

some dating back to 1930, bridges performed relatively well. The area of bridges affected extended from 20 km south of Sendai to 90 km northeast of Sendai. Refer to Figure 6.1 for location of bridges discussed. Table 7.2 summarizes the performance of those bridges inspected following the earthquake.

The UJNR inspection team arrived in Japan 10 days following the earthquake. The response plan to repair damage and open bridges incorporated by the Japanese Government was most impressive. Three bridges in or near Sendai which suffered major pier damage were in the process of being repaired and open to traffic. Other bridges in outlying areas were either in various stages of repair or plans were being made to build replacement structures. Following is a description of damage to those visited by the UJNR inspection team.

Kin-noh Bridge

The Kin-noh Bridge, (Figures 7.2 - 7.10) located about 65 km northeast of Sendai on National Highway, Route 346, is a two-lane, 15 span multi-configuration structure that is 575 meters long. The structure was constructed in 1956 and is comprised of nine simply supported plate girder spans, each 28 m in length; four of the spans are totally suspended; five are simply supported through-truss spans, each 60 m in length; and one is a simply supported plate girder span, 23 m in length. Three major earthquakes have occurred in the region since construction of the Kin-noh Bridge: (1) in 1962 (2) on February 20, 1978, in which significant damage occurred at one of the abutments and to the bearing devices; and (3) the current earthquake in which one of the suspended spans dropped. Repair work from the February 20 earthquake was underway at the time of the June 12 earthquake and had included the replacement of bearings on the five truss spans and tying the truss spans together with restrainers. The abutment at the end of the nine plate girder spans had been shored, but not repaired. Miyagi Prefecture has proposed replacing the bridge at an estimated cost of 16 million dollars (3.2 billion yen).

Yuriage Bridge

The 10-span Yuriage Bridge (Figures 7.11 - 7.18), constructed in 1962, is located 1.2 km from the mouth of the Natori River on the outskirts of Sendai and is 107 km from the epicenter. It has seven prestressed concrete T-girders each 45 m in length and three main spans which are twin cell, segmentally constructed, post-tensioned concrete box girders, 60, 90, 60 meters in length. The bridge was open to one lane of traffic because of heavy column damage. No damage was reported to the three-span box structure. Excavation at the first pier at the opposite side of the bridge was being done to determine the extent, if any, of foundation damage.

Sendai Ohashi Bridge

The Sendai Ohashi Bridge over the Hirose River on Japan National Highway, Route 4, constructed in 1965, suffered heavy pier damage (Figures 7.19 - 7.27). The structure is a nine-span, simply supported composite concrete and steel plate girder bridge with 34 m span lengths. The bridge had been retrofitted at points across the joints at the piers with steel restraining plates bolted to the girder webs. The bridge was closed to traffic the night of June 12 while temporary pier supports were constructed at two of the more severely damaged piers.

Although the UJNR team inspected the bridge site only 11 days after the earthquake, repair efforts were well underway, making it impossible to view much of the original damage.

Abukuma Bridge

The Abukuma Bridge (Figure 7.28), located about 20 km south of Sendai on National Highway, Route 6, near the junction of Route 4, is a two-lane, 17-span structure 571 meters long. The structure is comprised of eight plate girder approach spans, each 18 m in length, seven through truss-spans, each 55 m in length, which cross the Abukuma River, and two 18 m plate girder spans. Significant damage occurred to the portal frame piers which were being repaired at the time of the inspection (Figures 7.29 and 7.30).

TABLE 7.2
Summary of Highway Bridges Inspected

Name	Map Location No. from Fig. 6.1	Type	Main Damage
Kin-noh	35	Steel Plate Girder, Through Truss	Down-in span dropped out, bearings dislodged.
Yuriage	22	Prestressed Concrete I-Girders and Concrete Box Girder	Massive pier cracking, bearing dislodgment; pier settlement, abutment cracking.
Sendai	37	Steel Plate Girder	Massive pier cracking footing damage, bearings dislodged, abutment damage.
Abukuma	23	Steel Plate Girder	Pier cracking.
Kaihoku	29	Steel Box Girder	None. Settlement of roadway at abutment.
Tenno	30	Steel Plate Girder and Tied Arch	Pier cracking.
Kitakami	36	Steel Deck Truss	None. Apron settlement at abutment.
Kimazuka	27	Steel Plate Girder	Bearing dislodgement; possible pier tilting.
Maiya	34	Steel Gerber Truss	Brittle fracture of top chord member and buckling of top lateral truss bracing.
Toyoma	33	Concrete T-Beam	Flexural cracking of T-beams and shear crack- ing of hinge seats; abutment cracking.
Ono	26	Steel Plate Girder	Abutment damage, bearing damage, and possible pier tilting.
Iinogawa	31	Steel Box Girder	Bearing dislodged.
Yanaizu	32	Steel Deck Truss	Abutment settlement and bearing damage.



Figure 7.2 General view of the Kin-noh Bridge

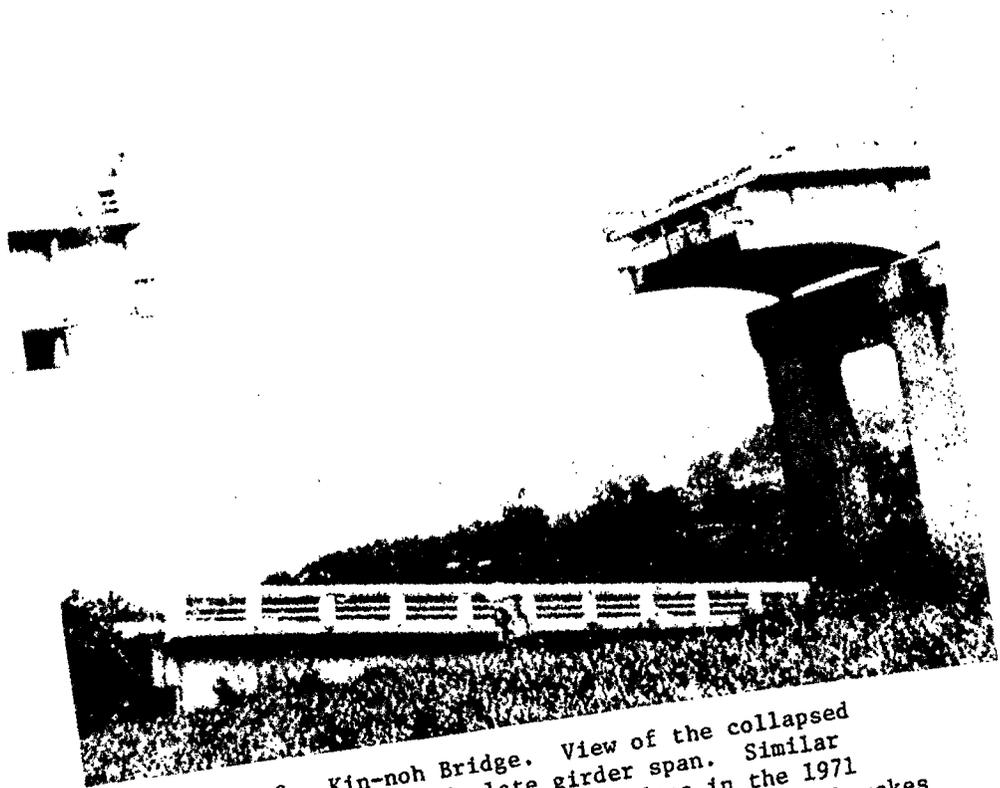


Figure 7.3 Kin-noh Bridge. View of the collapsed suspended plate girder span. Similar damage occurred to bridges in the 1971 San Fernando and 1976 Guatemala earthquakes because of lack of superstructure restraint and small bearing seats. Suspended spans are no longer used in seismically active areas. (Courtesy J.M.O.C.)

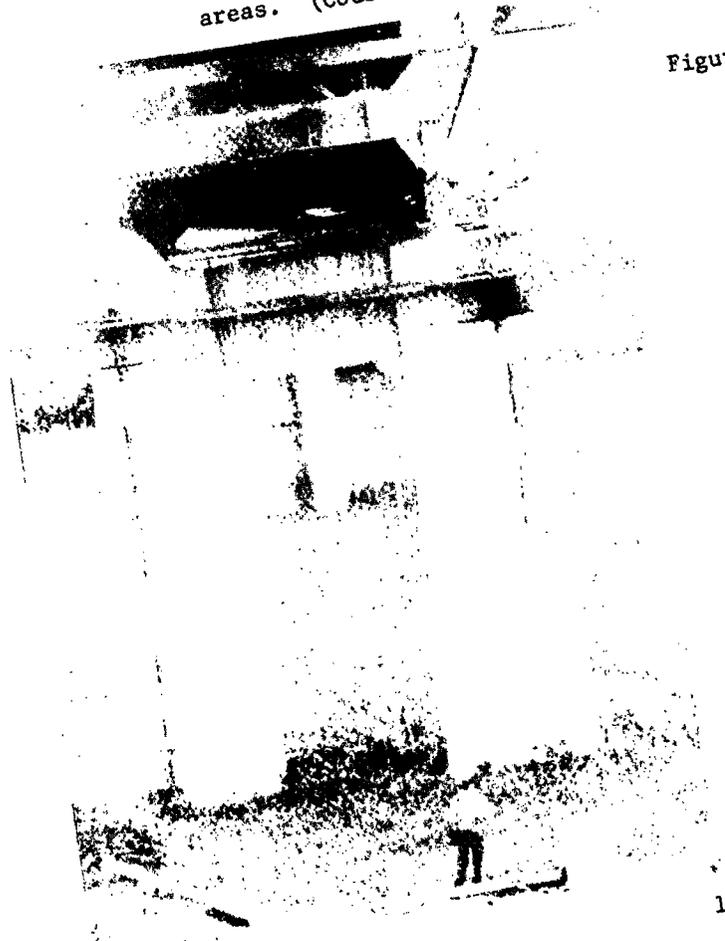


Figure 7.4 Kin-noh Bridge. The only visible pier damage occurred at Pier 8, which is adjacent to the collapsed suspended span. Shear cracking extended 125 cm through the 152 cm deep pier, approximately one-fourth the way up the column from grade.



Figure 7.5 Kin-noh Bridge. The girders at Pier 8 displaced longitudinally toward the abutment 55 cm allowing the unrestrained suspended span to drop off the 45 cm hinge seat. The movable girder bearing plate came to rest at the edge of the pier cap. The fixed bearing on Pier 7, the opposite side of the suspended span, displaced longitudinally 0.5 cm.

Figure 7.6 Kin-noh Bridge. Evidence of minor transverse displacement of the main girder with broken keeper. This reportedly occurred at the time of the February 20 earthquake.



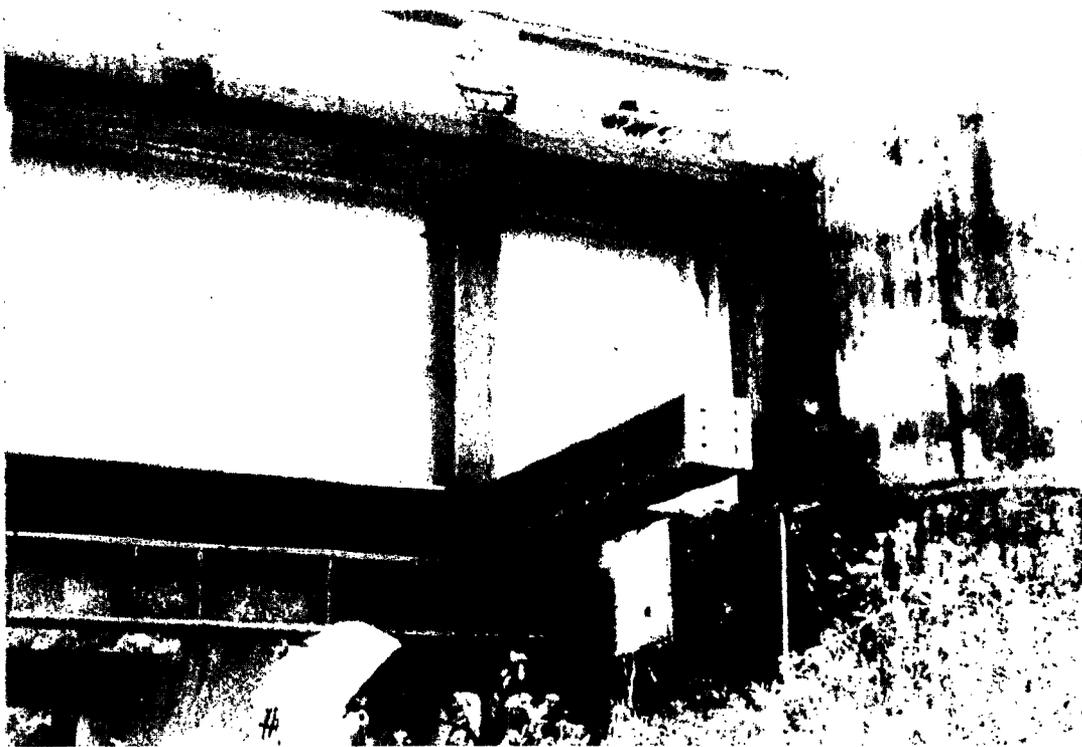


Figure 7.7 Kin-noh Bridge. Damaged abutment from the February 20, 1978, 6.7 magnitude earthquake. New web stiffener at point of temporary shoring.

Figure 7.8 Kin-noh Bridge. Detail of bearing damage and abutment ledge failure, from February earthquake. Note extension of anchor bolt caused by 20 cm displacement of span towards abutment.





Figure 7.9 Kin-noh Bridge. Extension of anchor bolts at Pier 6. The foreground shows a portion of repaired lower chord truss member.

Figure 7.10 Kin-noh Bridge. Bearing restraining device used on the repaired bearing supports of the truss spans. The restrainers were placed before the June 12 event.



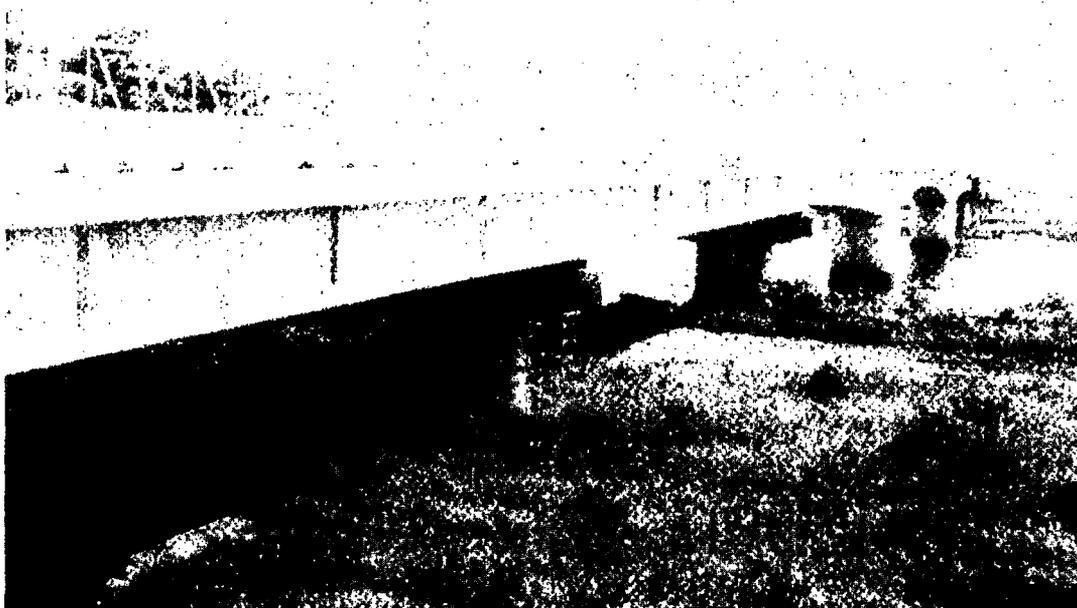


Figure 7.11 General view of the Yuriage Bridge showing the first two columns which were heavily damaged.

Figure 7.12 Yuriage Bridge. Liquefaction in the flood plan below the bridge.

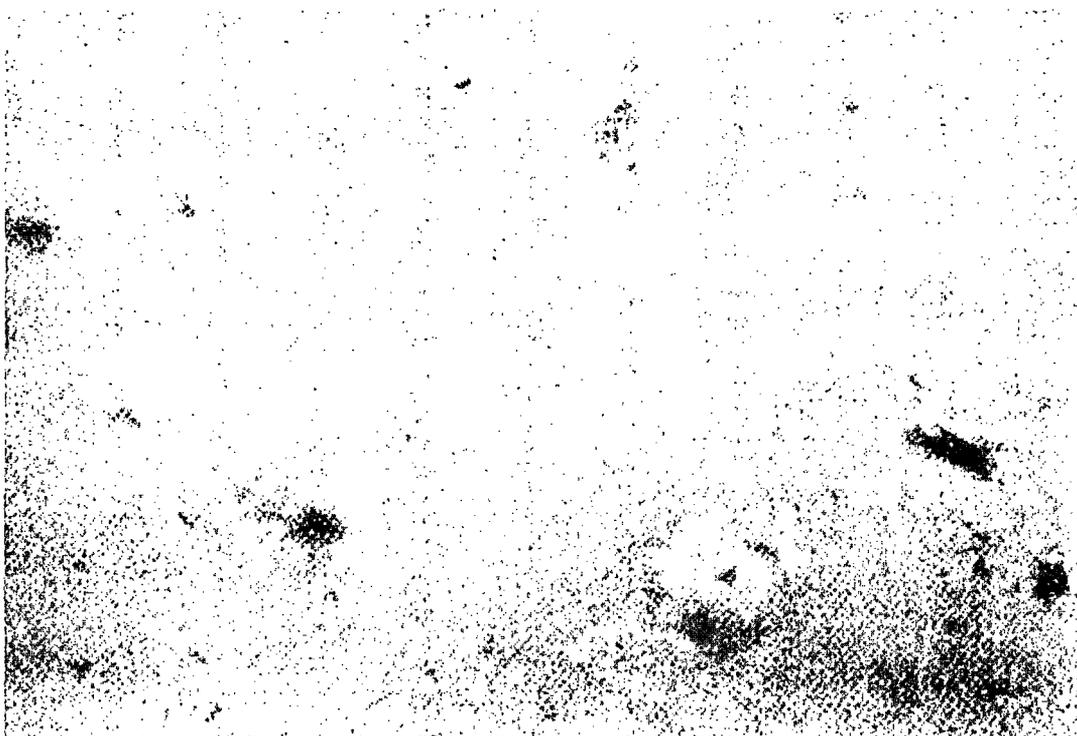




Figure 7.13 Yuriage Bridge. Evidence of light girder impacting with the abutment and pronounced shear cracking of exterior girder at the bearing.



Figure 7.14 Yuriage Bridge. Pier 1, founded on a caisson 19 m deep and 2 m by 4 m in plan, suffered heavy shear cracking. The pier cap was reported to have settled uniformly 5 cm.



Figure 7.15 Yuriage Bridge. The face of Pier 1 showing severe distress. The plaster of paris patchwork is used to determine if additional pier cracking has occurred.

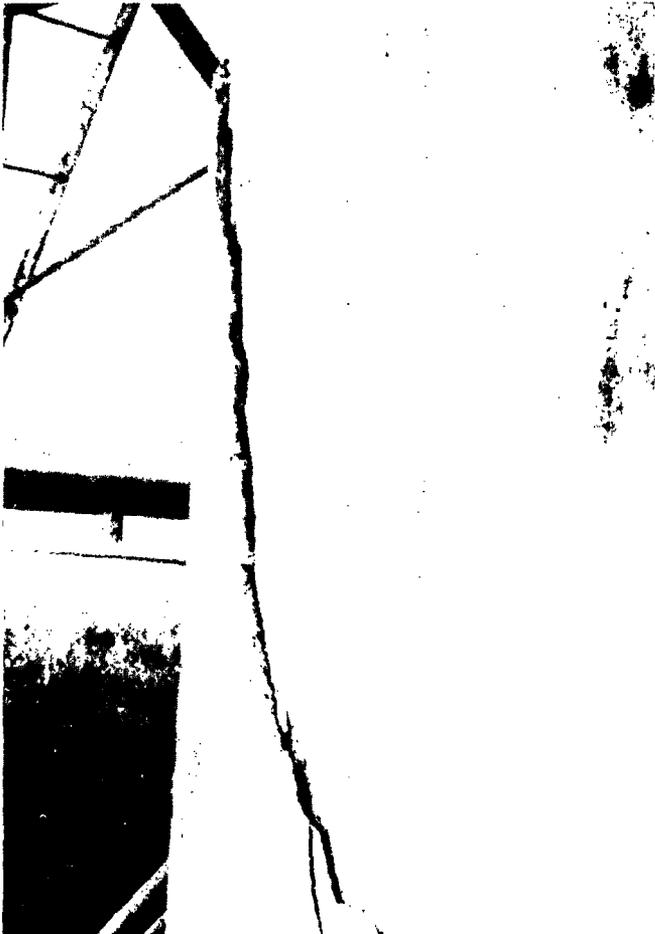
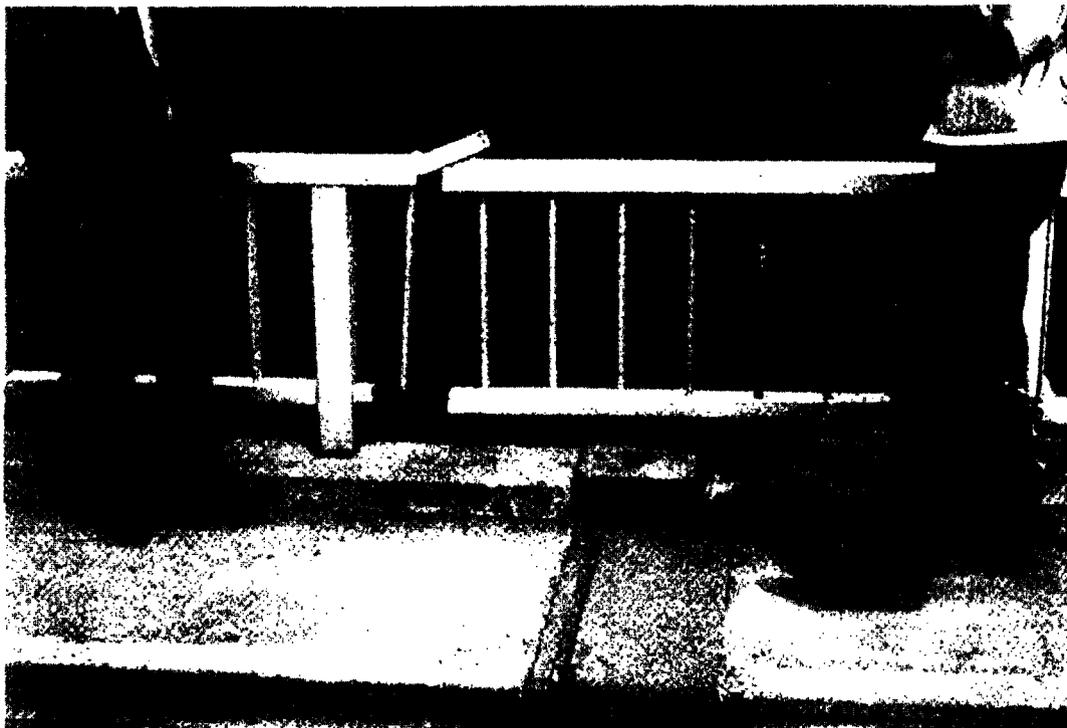


Figure 7.16 Yuriage Bridge. Detail showing 1 cm offset of cracking, indicating torsion in pier.



Figure 7.17 Yuriage Bridge. Temporary girder supports at Pier 1. Bearings showed evidence of girder displacement - broken keeper and containment plates.

Figure 7.18 Yuriage Bridge. Evidence of 8 cm of longitudinal movement as shown at the handrail expansion joint, Pier 2. However, there was no evidence of damage to the girders or the second pier.



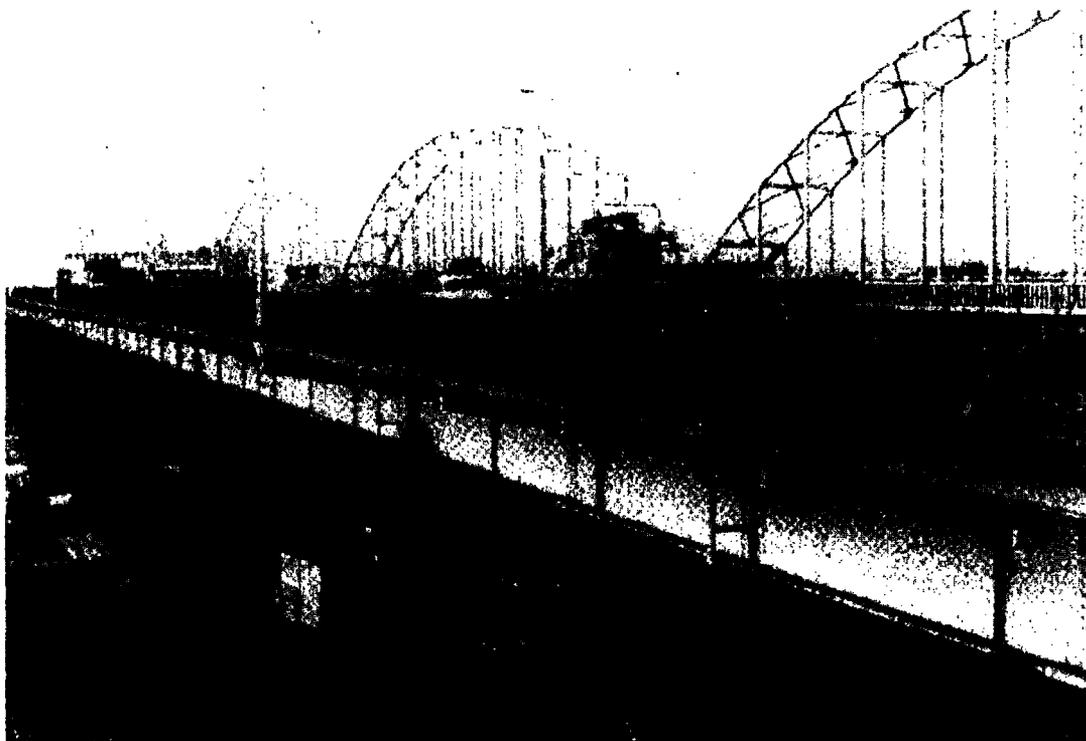


Figure 7.19 General view of the Sendai Ohashi Bridge. The deck arch bridge in the background, which is comprised of two steel plate girders with cross bracing and supported on slender circular columns, carries an industrial water pipeline and was reportedly undamaged.

Figure 7.20 Sendai Ohashi Bridge. Temporary cribbing used to support the steel plate girders.





Figure 7.21 Sendai Ohashi Bridge. Typical pier configuration. The cross pier dimensions are approximately 5 m x 2 m. Note the massive pier caps. (Courtesy J.M.O.C.)

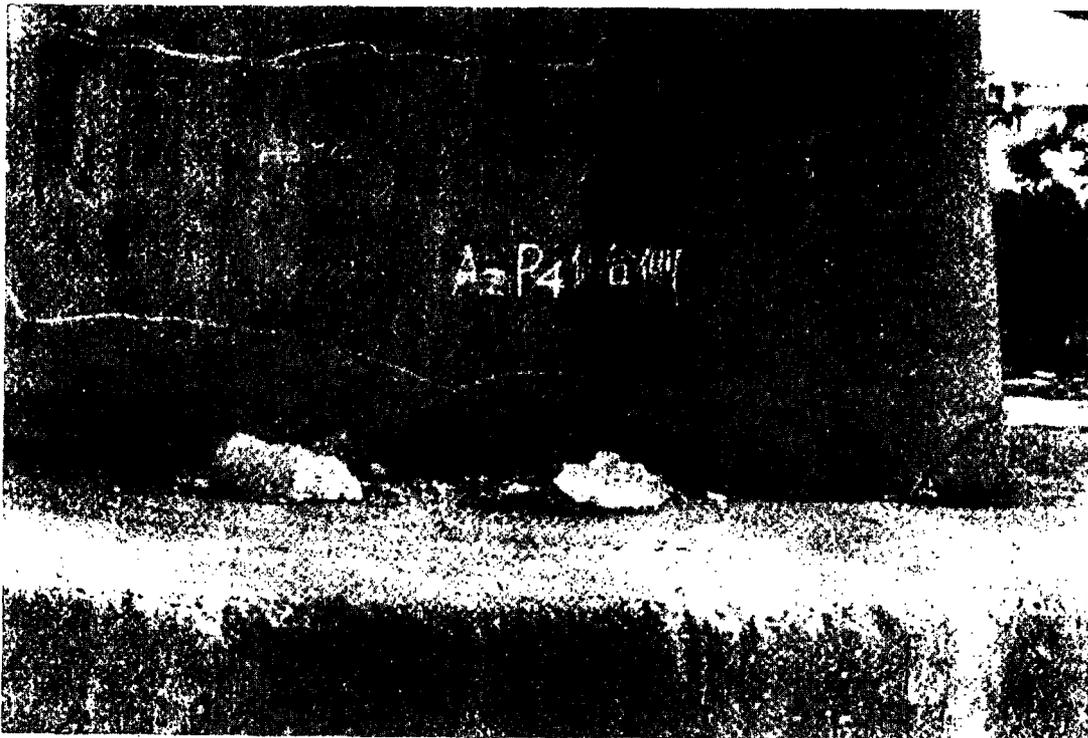
Figure 7.22 Sendai Ohashi Bridge. Typical pier damage at the construction joint between pier and cap. The vertical rebars are buckled across the joint. Significant concrete spalling is evident. Horizontal cracking around the pier was discovered upon excavation of soil around the piers. (Courtesy J.M.O.C.)





Figure 7.23 Sendai Ohashi Bridge. Detail showing buckled vertical rebar at the construction joint. Strong motion records in Sendai indicated approximately 100 gal. vertical accelerations. (Courtesy J.M.O.C.)

Figure 7.24 Sendai Ohashi Bridge. Typical damage to the base of a pier before repair.



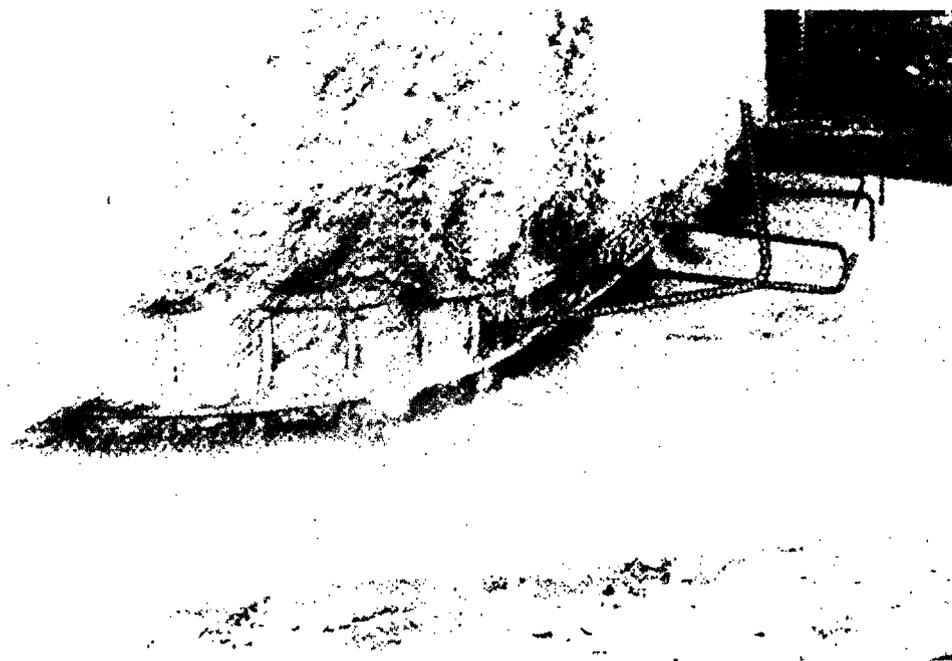


Figure 7.25 Sendai Ohashi Bridge. Typical damage being repaired at the base of the pier. Note the outward buckling of the underformed vertical rebar. The concrete cover had been roughened, the footing strengthened, and additional rebar placed to strengthen the pier.



Figure 7.26 Sendai Ohashi Bridge. Details showing the added reinforcing concrete form work. The pier thickness will be increased on each side by 50 cm at the top, tapering to 70 cm at the base.



Figure 7.27 Sendai Ohashi Bridge. Abutment damage. Bearing plate broken and evidence of girder impact at abutment.

Figure 7.28 General view of the Abukuma Bridge. Note the trace of pier cracking on the pier in the foreground and scaffolding at and surface preparation of the pier in the background.

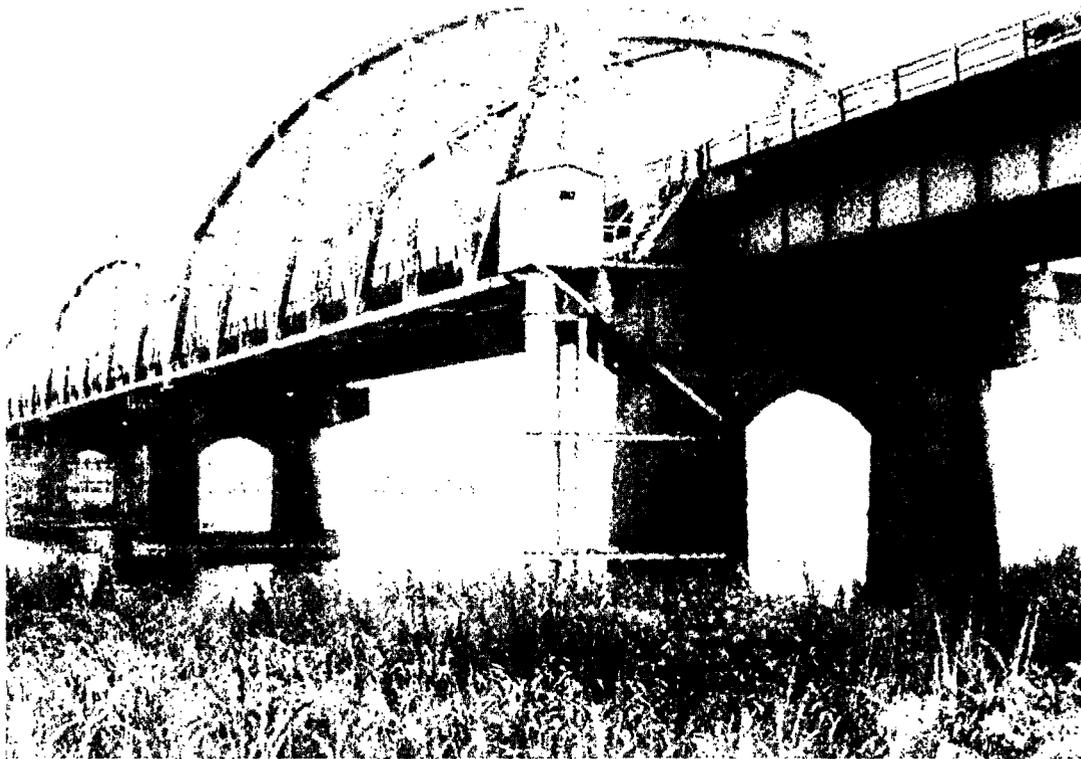




Figure 7.29 Abukuma Bridge. Outward buckling of vertical rebar at one of the damaged piers.



Figure 7.30 Abukuma Bridge. Typical repair of a damaged pier includes epoxy injection of cracks, epoxy covering of buckled rebar, preparation of existing concrete surface to accept fresh concrete, emplacement of vertical rebar into the footing and horizontal rebar into the pier, and an increase of the gross cross sectional area of the pier with new concrete. The technique is similar to that used on the Yuriage and Sendai Ohashi bridges.

Kaihoku Bridge

The Kaihoku Bridge, located on Principal Route 51, approximately 45 km northeast of Sendai, is a two-lane, five-span continuous single cell steel box girder, 285 m in total length (Figure 7.31).

The bearings are movable at all piers except Pier 2, Figures 7.32, where a SMAC-B type strong motion accelerograph is located. Hydraulic dampers acting in the longitudinal direction have been incorporated into the bearing system. All piers and the abutments are skewed. A free field SMAC-B instrument was located on rock between Pier 1 and Pier 2, approximately 30 meters from the structure. The axes of the pier and free field instruments were aligned with principal axes of the bridge. The peak recorded accelerations are:

	<u>Longitudinal</u>	<u>Vertical</u>	<u>Transverse</u>
Free Field	200 gal	113 gal	294 gal
Pier	500 gal or more (off scale)	138 gal	338 gal

The only damage noted was minor settlement of an abutment wing wall. Closer inspection by the Japanese revealed detachment of mortar near anchor bolts of the dampers. There was not visible damage to the piers or bearings, and no evidence of girder impacting with the east abutment.

Tenno Bridge

The Tenno Bridge, Figure 7.33, located approximately 50 km northeast of Sendai on National Route 45, is comprised of several steel plate girder approach spans with a tied arch main span. The total bridge length is 367 meters. The only damage occurred at the southwest wall pier where a 45° crack extended from the pier cap to a point one-third the way down the pier. Traffic was limited to one lane at the damaged pier.

Kitamami Ohashi Bridge and Dike

The seven-span, 400 m Kitakami Ohashi Deck Truss Bridge, completed in 1976, crosses the Kitakami River, 60 km northeast of Sendai on Principal Route 23 (Figure 7.34). The structure suffered no visible structure damage although there was minor settlement of the abutment apron. The structure was designed with the latest Japanese criteria and incorporated new abutment bearing details (Figure 7.35). Significant damage occurred to the dike and roadway along the Kitakami River south of the bridge site, (Figure 7.36). The most severe damage occurred along the approximately one-half kilometer length in which the roadway on top of the dike settled about 1.5 m. The roadway was closed to traffic, the dike sandbagged, and continuous steel sheet piling was being driven to stabilize the dike.

Kimazuka Bridge

The Kimazuka Bridge, constructed in 1931, is located on Principal Route 32, approximately 35 km northeast of Sendai (Figure 7.37). It is a 19-span, simple supported, steel plate girder structure 236 m in length. Damage occurred to the top of the piers where bearing shoes pulled out of the top of the portal frame (Figures 7.38, 7.39). Longitudinal movement of the girders almost exceeded the bearing area of the bent cap. Sand boils and ground cracking were noted at the bridge site.

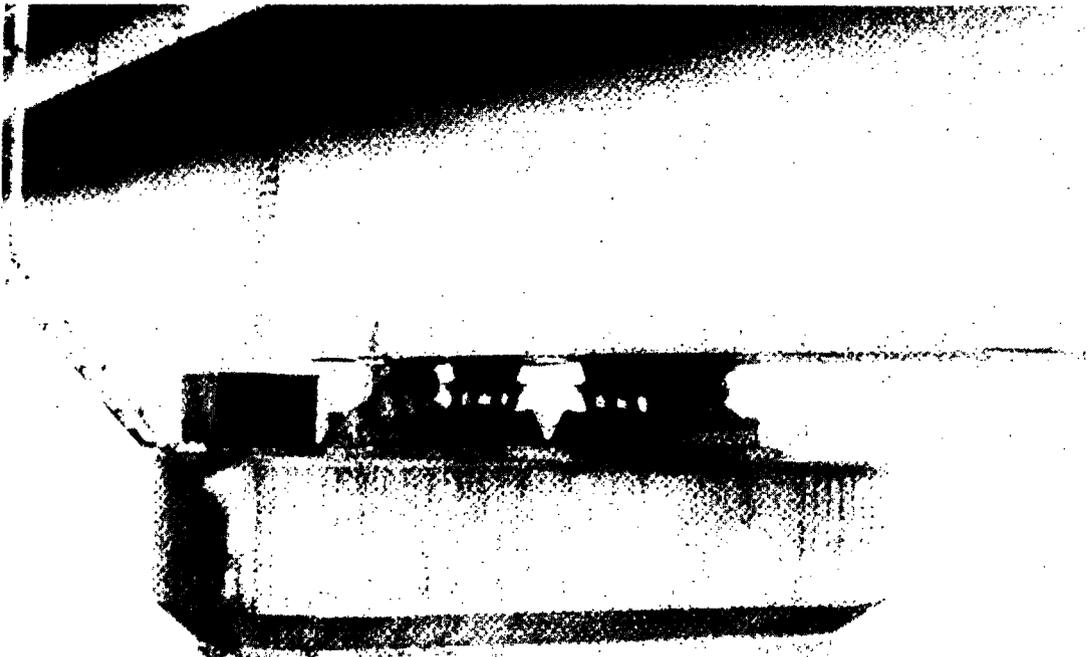
Maiya Ohashi Bridge

The Maiya Ohashi Bridge, Figure 7.40, is a three-span Gerber-truss bridge located on National Highway Route 342 approximately 62 km northeast of Sendai. The 181 meter long truss bridge, constructed in 1928, was closed to traffic because of a brittle fracture through the rivet holes of the top chord channel members at the first pier, Figure 7.41. Four steel plates had been welded around the top chord members. Some of the small steel angle top lateral bracing members were buckled in the vicinity of the pier, Figure 7.42. No damage was reported to either of the piers or abutments. The Maiya Bridge is scheduled to be replaced.



Figure 7.31 General view of the Kaihoku Bridge. (Courtesy J.M.O.C.)

Figure 7.32 Kaihoku Bridge. Pier 2 showing the SMAC-B2 instrument (which recorded a peak acceleration greater than 500 gal. in the longitudinal direction) and the fixed bearing and hydraulic damper system.



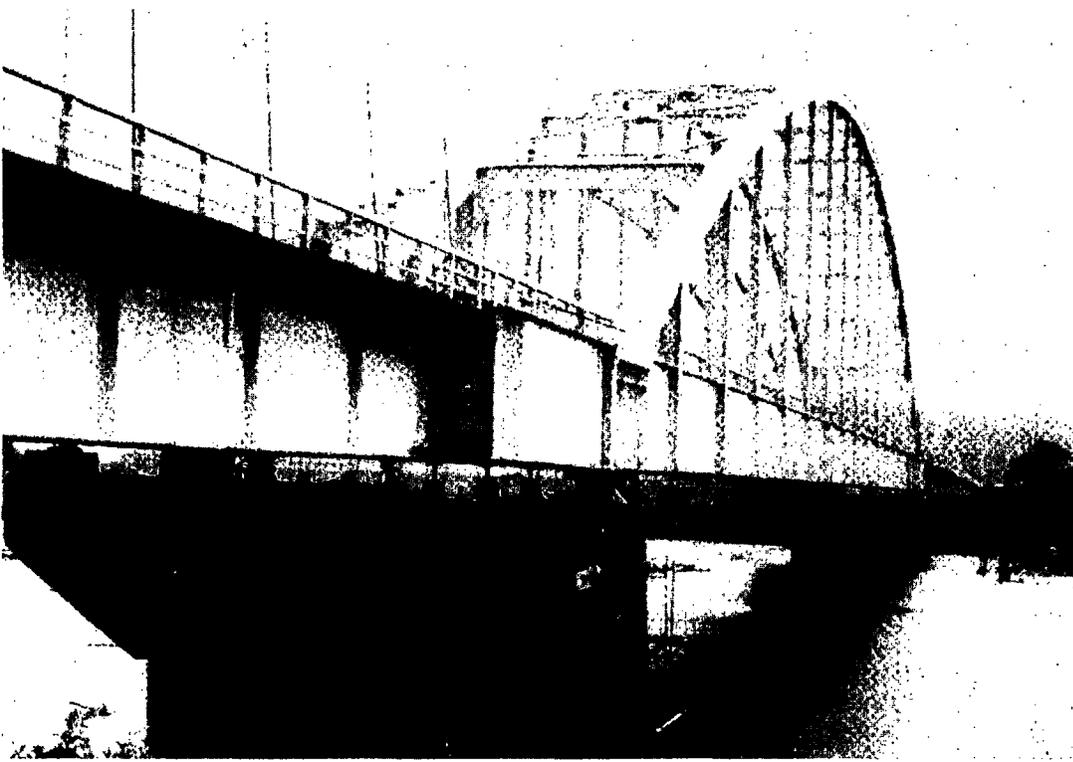


Figure 7.33 The main tied arch span of the Tenno Bridge with the cracked wall pier in the foreground. Note the smaller, pedestrian bridge in the background.

Figure 7.34 Kitakami Ohashi Bridge. No structural damage was reported.



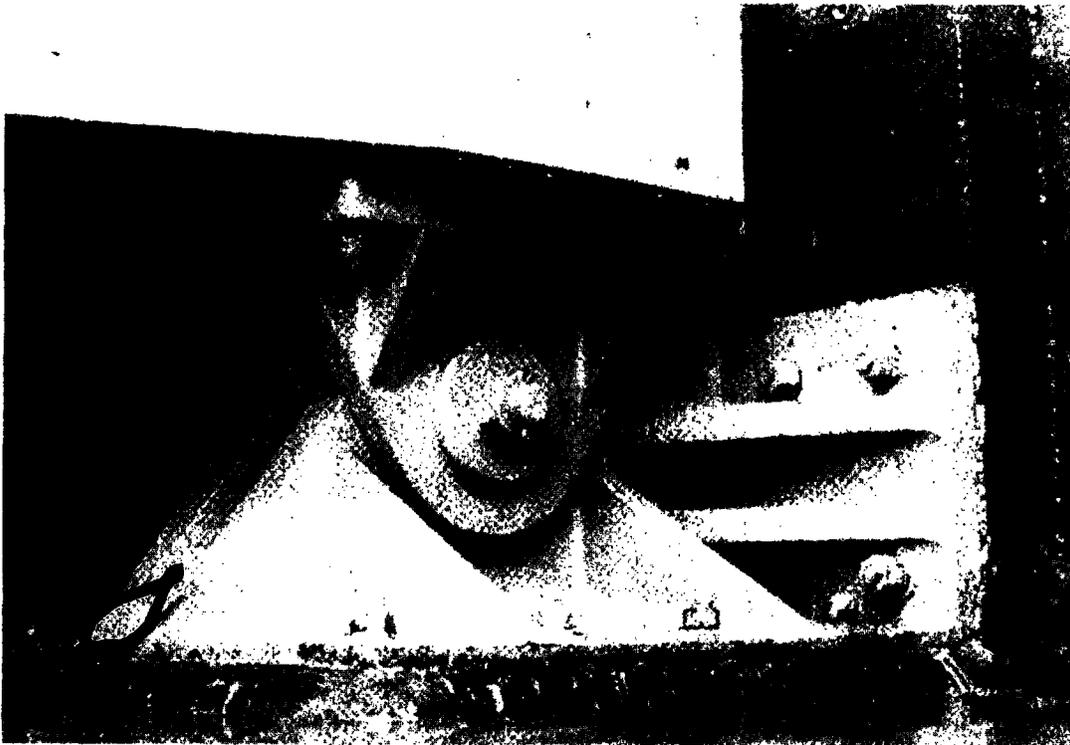


Figure 7.35 Kitakami Ohashi Bridge. Detail of a seismic bearing device at the abutment.

Figure 7.36 Road damage and temporary stabilization of the Kitakami Dike near the bridge site.





Figure 7.37 Spalled concrete at bent cap of Kimazuka Bridge.

Figure 7.38 Longitudinal displacement of superstructure. Note the temporary structure which spans the dislodged main span.





Figure 7.39 Vertical displacement of dislodged span.

Figure 7.40 The Maiya Ohashi Bridge.



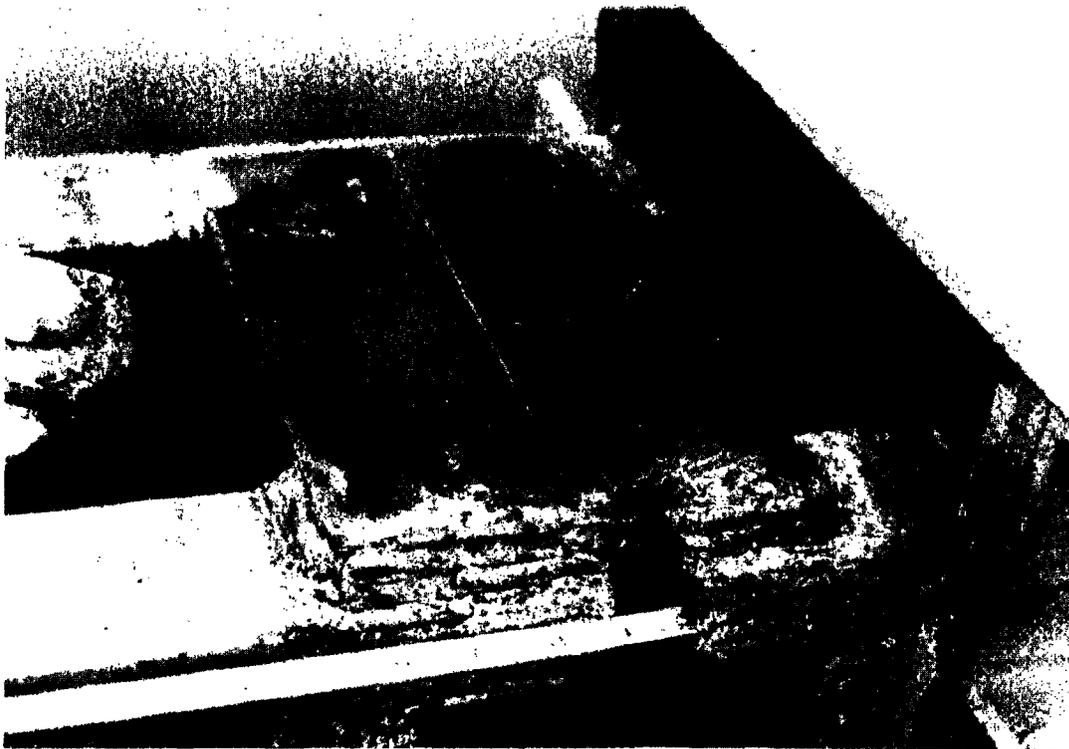
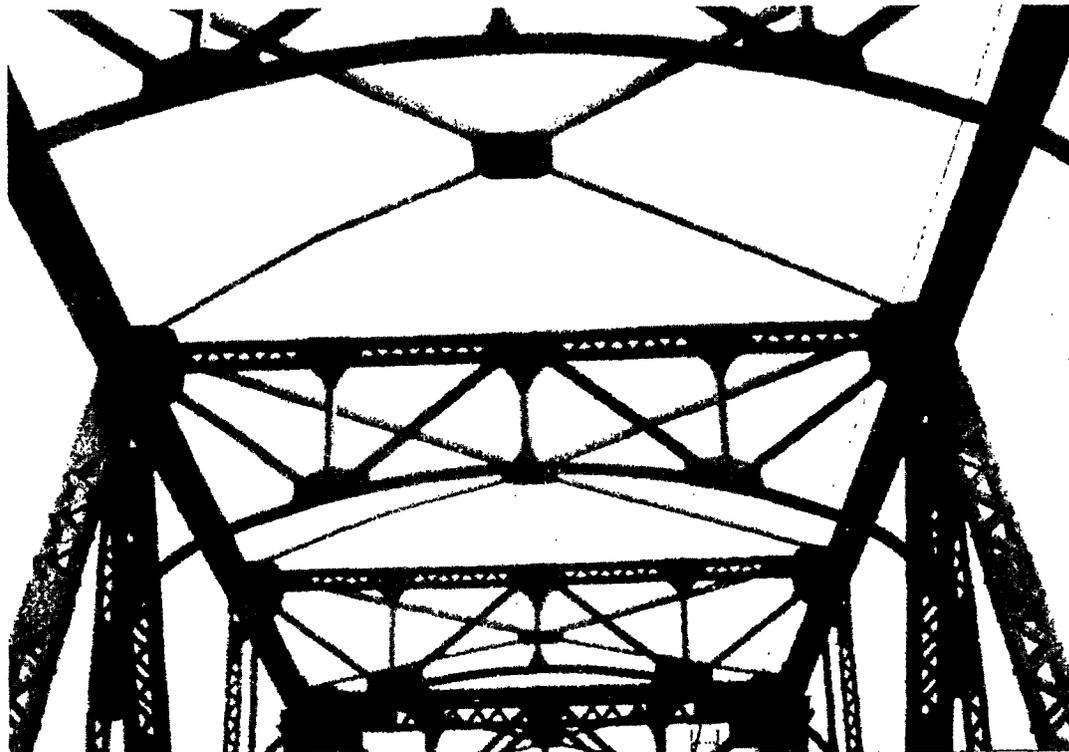


Figure 7.41 Maiya Ohashi Bridge. Steel plates welded to the top chord channel members. Note the clean fracture at a line passing through the centerline of the rivet holes of the lattice bracing and the permanent 2.5 cm separation.

Figure 7.42 Maiya Ohashi Bridge. Buckled lateral bracing of the overhead truss.



Toyoma Bridge

The Toyoma Bridge is a 13-span concrete T-beam bridge constructed in 1945, (Figure 7.43). Prior to the earthquake, the bridge, located about 60 km northeast of Sendai, was restricted to automobile traffic because of damage suffered during the February 20, 1978, earthquake. The bridge was closed following the June earthquake. Flexural induced cracking of the girders occurred at the center of the spans and at the haunched ends over the piers. Shear cracking was also noted at the corners of the concrete hinge seats of several suspended spans. The ground motion, between 0.1 and 0.2g, was sufficient enough to induce pavement cracking of the roadway.

7.4 HIGHWAY DAMAGE

Widespread highway damage (e.g., Figure 7.44) occurred in the region north and east of Sendai. Typical damage included settlement of bridge approaches, cracking of pavements, failure of roadway embankments, and blockage of roads from rockslides. This type of damage has been documented in reports on previous large earthquakes in Alaska, Japan, California, and Guatemala and is virtually impossible to design against.

A major toll road expressway, owned and operated by the Japan Highway Public Corporation, experienced pavement cracking in numerous spots where fill material was used. Additional settlement occurred at the approach to bridges along the expressway which was closed from the time of the earthquake until 7:00 a.m., June 15, while temporary repairs were made.

Reinforced concrete approach settlement slabs were used at many of the bridge abutments. Use of the slabs forced settlement to occur at the end of the slab instead of at the abutment, as illustrated in Figure 7.45.

In areas of rugged terrain, particularly along the West Coast of Japan, roadways are protected against earthquake induced landslides by stabilizing the steep slopes above the roadway with a covering of shotcrete. Rockslides are contained or controlled by emplacing wire mesh screening which is anchored and hung from the crest of the slope and extends down to the roadway or by the construction of rock bins at the base of the roadway cut (see Figures 7.46 and 7.47). These techniques worked quite well in the January 1978 Off-Izu earthquake, but were not utilized in the area affected by the June earthquake.

7.5 RAILROAD DAMAGE

The Japanese electric railroad serves a vital role in Japan. The train is relied upon by most Japanese in major cities such as Sendai as the means of commuting between home and work. The train is also the most popular form of intercity travel within Japan. Major damage was reported at one rail station when the retaining wall supporting the boarding platform collapsed, resulting in track blockage. The main Sendai train station, including the structural portion of the electrification system, was reportedly undamaged. However, the trains were inoperative because of massive power failures. Several rail bridges were severely damaged and are discussed below.

Eai River Rail Bridge

The Eai River Bridge (Figure 7.48), owned by the Japanese National Railways (JNR), is a dual eight-span steel plate girder structure 160 m in length, which is located 40 km northeast of Sendai. The superstructure is supported by massive unreinforced concrete gravity piers on caisson foundations. Ground acceleration in the area was estimated by the Ministry of Construction to be 200-250 gal. Two piers were severely damaged when large wedged shaped sections of concrete dropped out below a construction joint.

The JNR New Sendai Shinkansen Trunkline

JNR is constructing the New Sendai Shinkansen Trunkline, a series of elevated structures for the fast train, extending through Miyagi Prefecture to the northern tip of Honshu. The line is scheduled for completion in 1981. The majority of the elevated structures, a series of prestressed concrete T, I, and box girders with varying configurations of single and multiple column bents, are completed and experienced varying degrees of damage, namely to the



Figure 7.43 General view of the Toyoma Bridge which was closed to traffic. The columns in the background support an independent steel box girder pedestrian structure which was undamaged.

Figure 7.44 Typical Road Fill Failure.



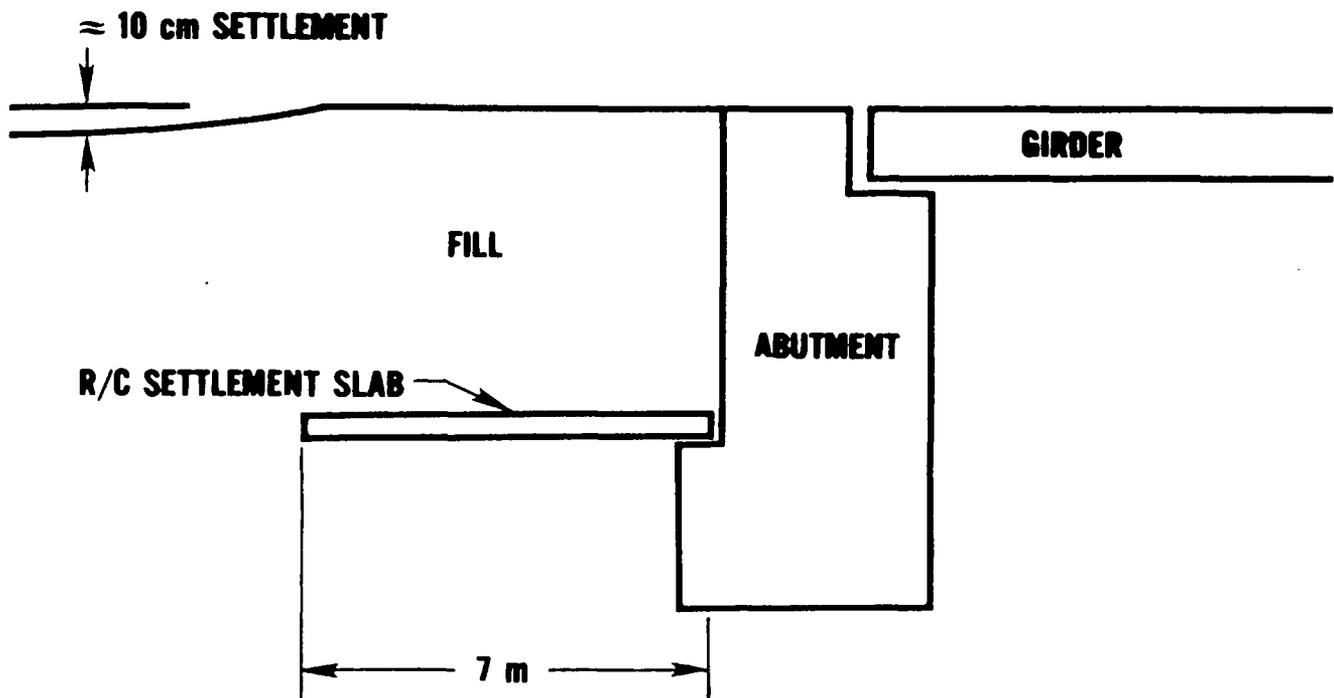


Figure 7.45 Detail of Reinforced Concrete Approach Settlement Slabs.

Figure 7.46 Wire mesh screening used to contain land and rockslides along highways.

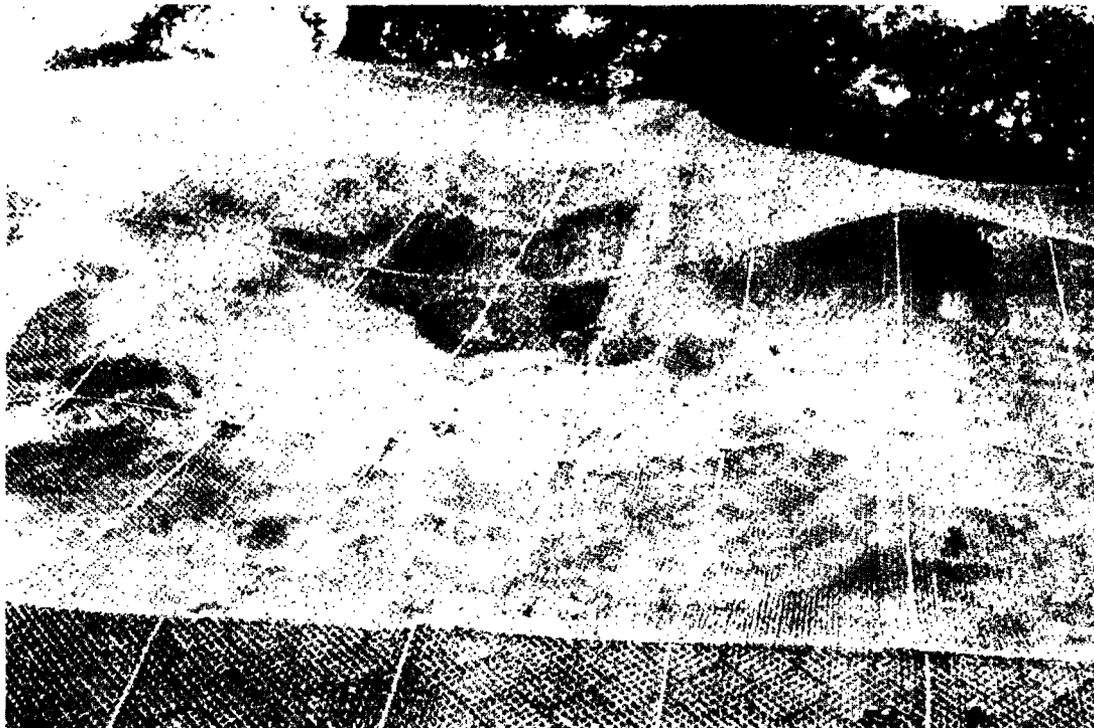




Figure 7.47 Steel bins constructed to contain rockslides along highways.

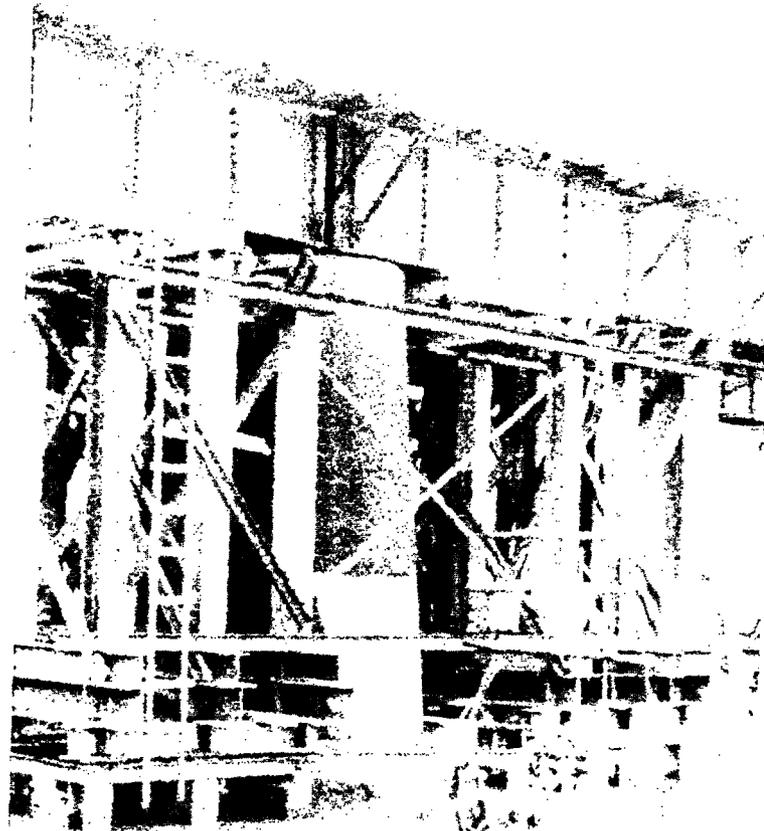


Figure 7.48 Eai River Bridge. Damaged pier of Eai River Rail Bridge. Temporary pier supports were constructed following the earthquake. Full train service was established approximately 10 days after the earthquake.

bearing shoes and columns (see Figures 7.49 - 7.54). Damage was concentrated to those new structures located approximately 30 to 40 kilometers northeast of Sendai. All structures were designed using the 1971 Japanese seismic code.

7.6 TUNNEL PERFORMANCE

Five short, unreinforced concrete-lined highway tunnels through rock, located about 20 km northeast of Sendai on National Highway Route 45, suffered no apparent damage (e.g., Figure 7.55). The Japanese National Railways reported that one concrete-lined tunnel on the Sendai New Shinkansen Line about 40 km northeast of Sendai had hairline cracking.

7.7 CONCLUSION

The June 12 Miyagi-ken-oki earthquake demonstrated the ability of the Japanese Government, both local and national, to respond to the adverse conditions created by a major natural disaster. Specifically, the prompt enactment of their disaster response plan alleviated major problems which could have resulted from the prolonged loss of major transportation routes. The plan allowed for the immediate identification of damaged structures, emergency temporary repairs, and initiation of permanent repair within a matter of days after the earthquake. Major routes, although severely damaged, were opened to traffic within three days after the earthquake.

Bridge substructures which were severely damaged were massive reinforced concrete piers, which responded essentially as non-ductile, rigid bodies to the earthquake motion. In spite of the major damage of these elements, the designs proved satisfactory in that collapse was avoided and the bridges remained operational for emergency use. Although this type of construction proved successful, it would be prohibitively expensive for use in the United States where the philosophy is to utilize more ductile, energy absorbing designs.

Evidence of pier tilting and abutment movement existed which probably caused rather extensive damage to bridge bearing devices. This type of movement is exceptionally difficult to control. This damage indicates the need to perform in-depth site investigations in areas where high water tables exist and to make special considerations in foundation design.

The Kin-noh Bridge was being repaired as a result of damage induced by the February 20 earthquake. Bearings were being strengthened and spans were being restrained at their expansion joints. The failure of the suspended span which had not been retrofitted could be expected and demonstrates once again the need to provide for continuity of the superstructure across all joints.

Damage to bridges inflicted by this and past earthquakes reinforces the need to consider an aggressive retrofit program for those structures built under older seismic design criteria. The most vulnerable components requiring retrofit are bearings and columns, including connections into the foundation. Modest investments can significantly reduce future damage and help to avoid collapse of older, important structures.

As in previous earthquakes, significant damage occurred to roads in the area of strong ground shaking. Embankments fail, fill material settles, and land- and rockslides block roads and trackage. These types of damage are difficult to control, although stabilization and control techniques utilized by the Japanese do help. Special consideration, including the use of control and stabilization techniques described earlier in this chapter and/or the development of specific emergency response plans in susceptible areas, should be given to those important routes which must remain open following a major earthquake.

Given the magnitude of the Miyagi-ken-oki earthquake, transportation structures in general performed very adequately. Air, train, bus, and highway travel, although temporarily interrupted, did not adversely hinder emergency operations or affect the general movement of commerce or people.

7.8 REFERENCES

- 7.1 "Earthquake Resistant Design for Civil Engineering Structures, Earth Structures, and Foundations in Japan," compiled by the Japan Society of Civil Engineers, Tokyo, Japan, 1977.
- 7.2 "Standard Specifications for Highway Bridges," Twelfth Edition, American Association of State Highway and Transportation Officials, Washington, D.C., 1977.

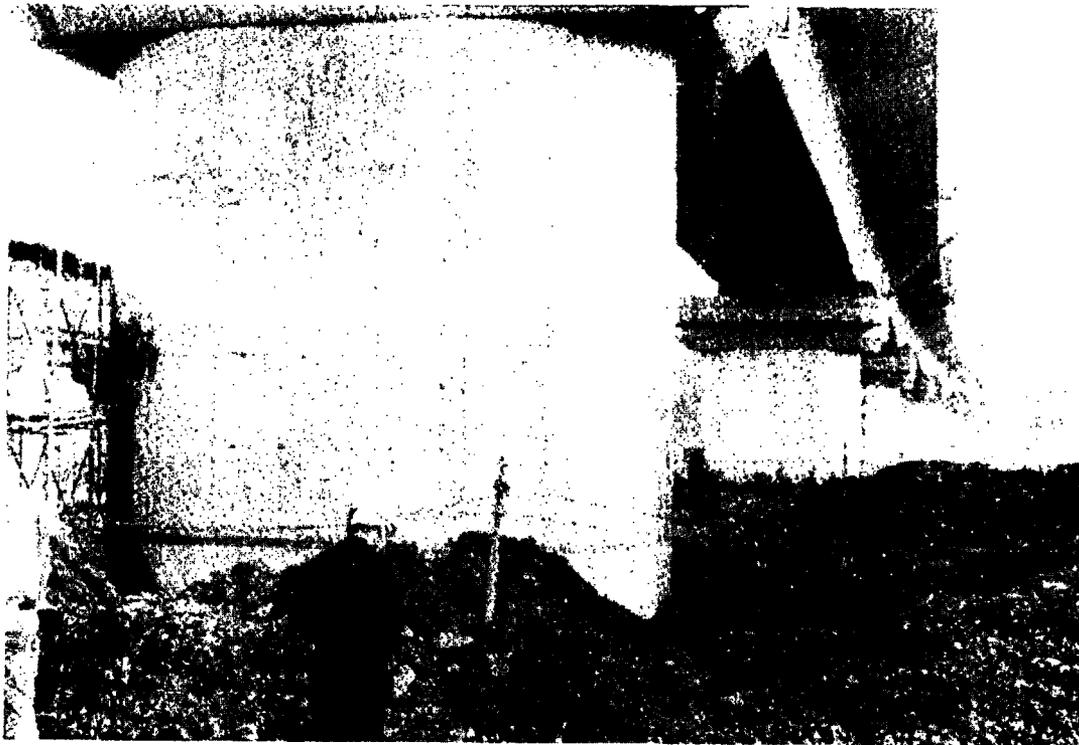


Figure 7.49 The Natori River Bridge is a three-span continuous single cell reinforced cast-in-place concrete box girder structure on 3 m x 6 m piers approximately 8 meters above grade. Typical damage included cracking in the central part of the pier where the gross cross-sectional area of vertical steel was reduced.

Figure 7.50 Natori River Bridge. Detail of spalled concrete at the Natori River Bridge site showing the buckled vertical rebar.

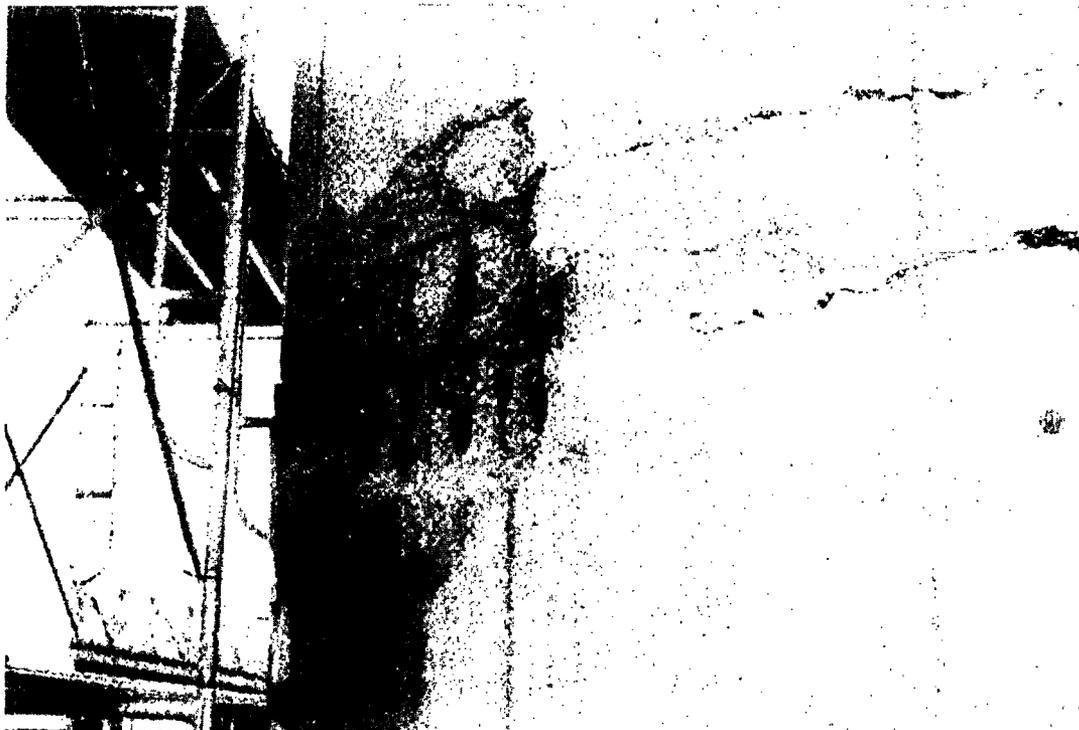
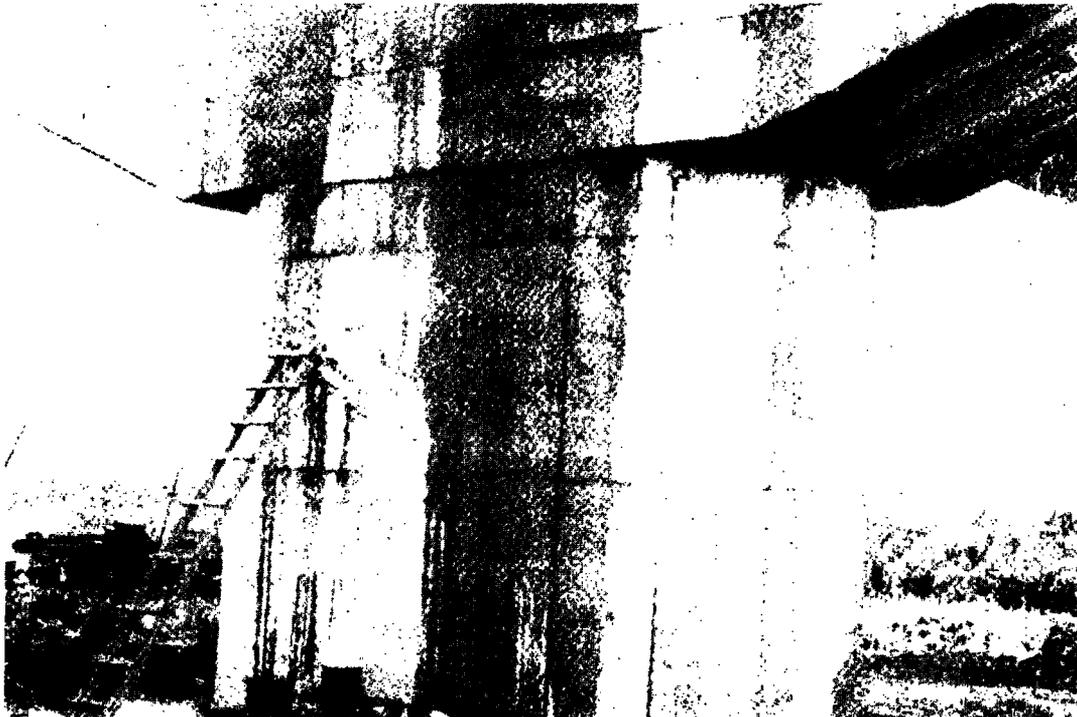




Figure 7.51 Typical structures which experienced pier cracking near the Rifu Construction Office of the Sendai Shinkansen Construction Bureau, JNR.

Figure 7.52 Shear cracking in the relatively lightly reinforced upper portion of the pier.



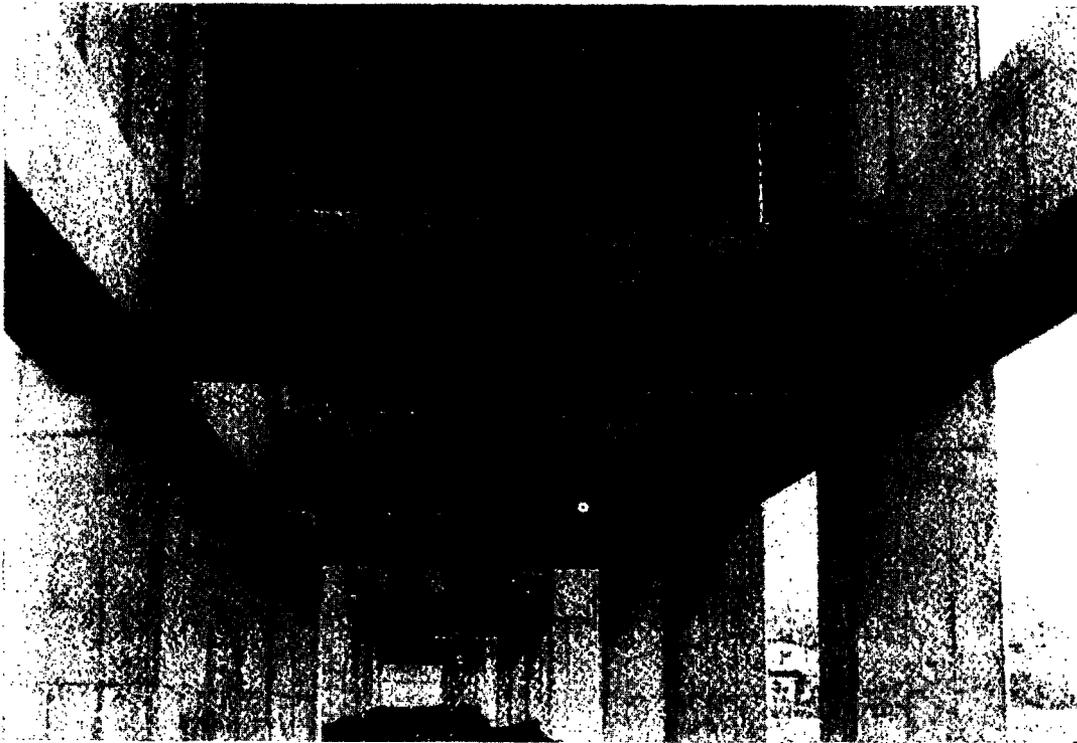


Figure 7.53 Tensile cracking of space frame tie beams near the Rifu Construction Office.

Figure 7.54 Failure of a bearing plate supporting a single cell box girder near the Higashi Sendai Construction Office. Girder displaced laterally 50 cm.



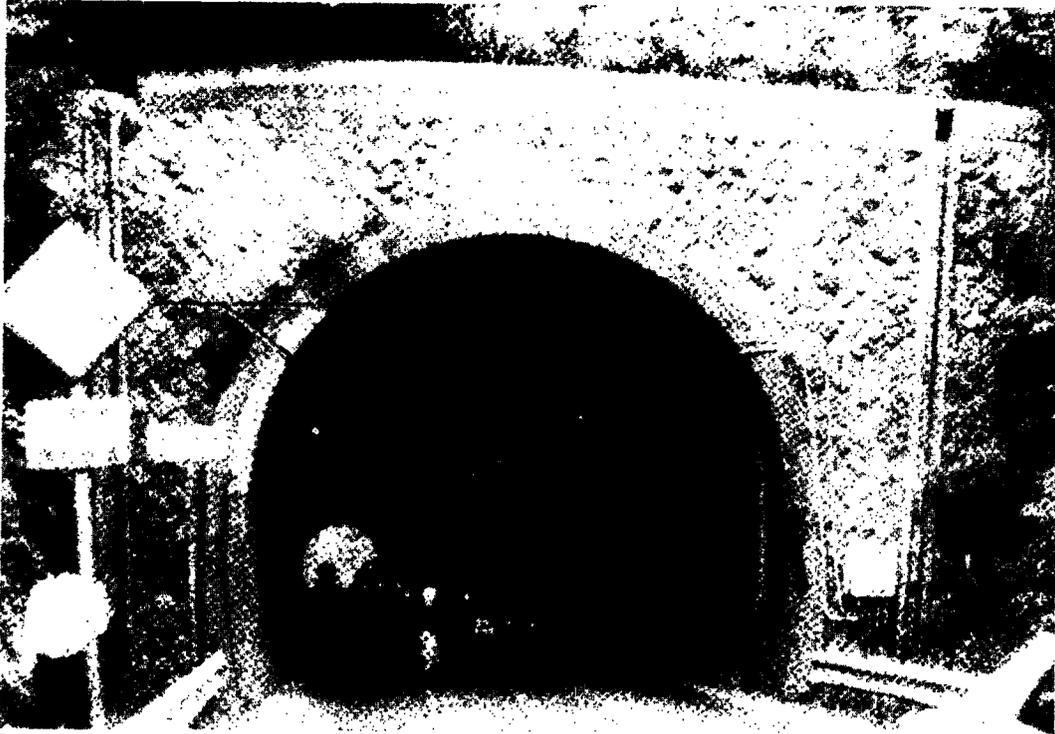


Figure 7.55 Typical undamaged highway tunnel on Route 45 along the coast between Sendai and Ishinomaki to the north.

8. LIQUEFACTION AND DAMAGE TO DIKES*

8.1 INTRODUCTION

The June 12, 1978, Miyagi-ken-oki earthquake caused soils to liquefy at several sites on the coastal flood plain bordering the Bay of Sendai. The engineering structures most extensively damaged by liquefaction were flood-control dikes composed of earth fill. The damage consisted primarily of cracking, settlement, and minor lateral spreading and slumping. During a trip to Miyagi Prefecture on June 26, 1978, six sites were visited where dike damage had occurred (Figure 8.1). Additional information on earthquake-induced dike damage was provided by officials of the Public Works Research Institute (PWRI), the Japanese government agency charged with building and maintaining river works. Liquefaction-induced damage also occurred in an uncompacted sand fill in the port of Ishinomaki.

8.2 SUMMARY OF DIKE DAMAGE

Reported damage sites are scattered in an arc extending from the Abukuma River on the southwest to the mouth of the New Kitakami River on the northeast (Figure 8.1). Within this region, damage occurred along parts of the Abukuma, Natori, Hirose, Yoshida, Eai, Naruse, Old Kitakami, and New Kitakami rivers (Figure 8.1, Table 8.1). Most or all sites are underlain by unconsolidated Holocene coastal flood plain deposits; a few may be underlain by Holocene alluvial fan deposits (Geological Survey of Japan, 1968; Geologic Map of Miyagi Prefecture). Many of the damaged dikes are founded on river channel deposits less than 500 years old. Because of the proximity of all dikes to rivers, the water tables under them are close to the ground surface at all times. A total of 28 linear kilometers of dikes was damaged in this earthquake, and total repair costs of dikes and other river works amounted to about 10 billion yen (approximately \$50 million) (Ministry of Construction of Japan, unpublished data). Most of this damage was caused by liquefaction.

The dikes are composed chiefly of compacted sand. They are built directly on alluvial fan or flood plain sediments with little or no ground improvement. Most dikes are several meters high, several meters wide at the crest, and have side slopes of 2 Horizontal: 1 Vertical or less. At the time of the visit, repairs to the dikes were already well advanced. The repairs consisted of regrading and filling cracks, placing sand bags, and driving steel sheet piles to reduce seepage under the dikes.

8.3 GEOLOGIC SETTING

Most sites of damage are on the coastal plain bordering the Bay of Sendai; a few are on the margin of Natori River alluvial fan and may be underlain by alluvial fan deposits (Geological Survey of Japan, 1968; Geologic Map of Miyagi Prefecture). The coastal plain sediments are unconsolidated Holocene gravels, sands, silts, and clays primarily deposited by rivers; beneath most dikes these deposits are several tens of meters thick (Hase, 1967). The river deposits are of three main types: channel, natural levees, and back marsh deposits (Tohoku Regional Construction Bureau, MoC, unpublished data; H. Nakagawa, Tohoku University, unpublished data). Engineering structures including dikes founded on channel or back marsh deposits performed relatively poorly during the earthquake. Liquefaction occurred most commonly in channel deposits.

Performance of engineered structures founded on natural levee deposits varied from place to place. These deposits are generally thin, and the performance of structures was therefore strongly influenced by the materials underlying the natural levees (H. Nakagawa, Tohoku University, oral communication). Structures near the coast, founded on beach ridge and dune sand deposits sustained little damage in the earthquake. Natori River alluvial fan materials consist primarily of gravel but also contain a few thin layers of sand and silt (Hase, 1967).

* Prepared by David K. Keefer, U.S. Geological Survey, Menlo Park, California.

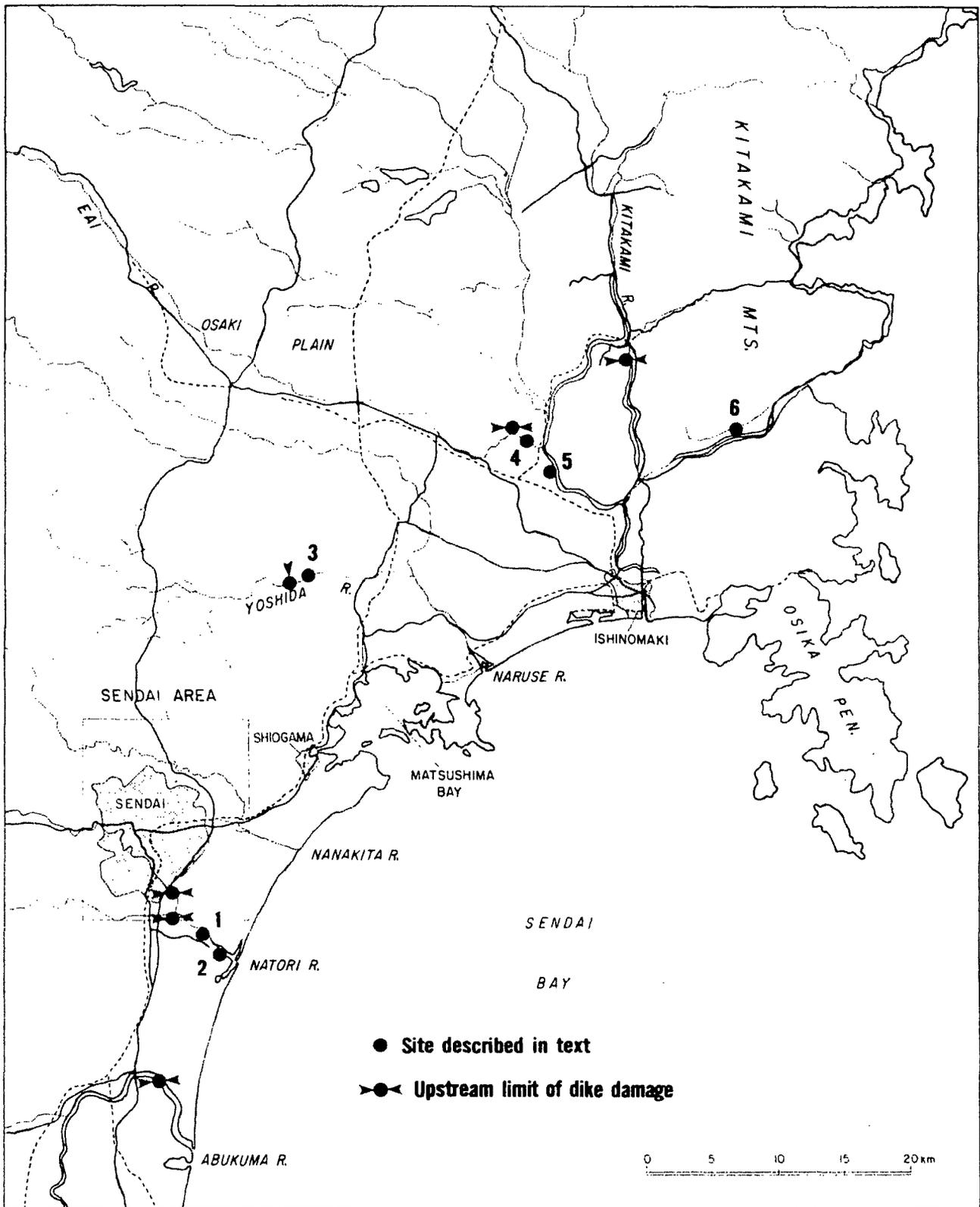


Figure 8.1 Dike Damage in Miyagi Prefecture

TABLE 8.1

DIKE DAMAGE IN MIYAGI PREFECTURE

River	Bank ¹	Number of damage sites	Total length of dike affected by cracking, settlement, lateral spreading, or slumping (kilometers)
Abukuma	left	2	0.38
	right	5	0.68
Natori	left	11	1.87
	right	6	2.17
Hirose	left	0	0
	right	5	0.38
Yoshida	left	9	0.51
	right	12	5.50
Eai	left	5	2.90
	right	6	0.21
Naruse	left	13	0.79
	right	10	1.08
Old Kitakami	left	3	0.15
	right	9	0.29
New Kitakami	left	16	7.13
	right	17	4.13
TOTAL		129	28.17

Information furnished by the Tohoku Regional Construction Bureau.

¹ Right or left relative to an observer facing downstream.

8.4 FIELD OBSERVATIONS OF DIKE DAMAGE

8.4.1 Natori River (Sites 1 and 2)

Lateral spreads, fissures, and sand boils were apparently widespread along the Natori River for 3 km upstream from its mouth (T. Tazaki, PWRI, oral communication). In this area the flood plain is underlain by fluvial sand that extends to a depth of 15 m or greater (Hase, 1967). Two damaged dikes in this area (Figure 8.1) were visited.

At Site 1, liquefaction caused slumping, lateral spreading, and settlement of up to 1.5 m along a 160-m-long section of the dike (Figures 8.2, 8.3, and 8.4). Longitudinal cracks several tens of meters long opened in the dike crest. Between the dike and the river, fissures striking obliquely to the dike formed, and sand was ejected from them (Figure 8.5). Other fissures trending parallel to the dike and the river formed near the river bank, more than 100 m from the base of the dike. The occurrence of fissures and sand boils in ground away from the dike indicates that liquefaction took place primarily in material beneath the dike and not in the dike material itself.

The configuration (Figure 8.4) and composition of this dike are typical of those seen throughout Miyagi Prefecture. The dike is composed primarily of compacted, fine to medium sand. It rises 2 m above the high water level of the river and is 4 m wide at its crest. Its riverward flank has a slope of 2H: 1V. The opposite flank descends as a series of slopes (2H: 1V) and benches to the agriculture land beyond.

The damaged section is built on a former channel abandoned by the river less than 500 years ago. Beneath the dike, fluvial sand extends to a depth of at least 60 m (Hase, 1967), and much of the top 15 m of sand is fine grained, loose, and well sorted (poorly graded) (Tohoku Regional Construction Bureau, MoC, unpublished data).

Liquefaction previously took place at this site during a M 6.7 earthquake in February 1978 (T. Tazaki, PWRI, oral communication). The same section of dike was affected and the same materials liquefied in both the February and June earthquakes.

At Site 2 (Figure 8.1), the dike is contained by a concrete retaining wall (Figures 8.6, 8.7, 8.8, and 8.9). A section of the retaining wall several hundred meters long moved about 30 cm toward the river. Longitudinal fissures opened in the dike behind the retaining wall and in a concrete pavement along part of the dike. The dike also settled by as much as 30 cm. This site, at the mouth of the river, is underlain by at least 20 m of sand (Hase, 1967).

8.4.2 Yoshida River (Site 3)

This was one of the most severely damaged sections of dike in Miyagi Prefecture. Settlements of up to 1 m occurred over a distance of 5 km, longitudinal cracks and scraps formed in the dike crest, bulges appeared in the lower slopes, and sand boils occurred along some cracks (Figures 8.10, 8.11, 8.12, and 8.13). The cracks and bulges indicate that lateral spreading and slumping took place. The damaged section rests on the fan-delta of a small stream, and a boring near this site penetrated 15 m of silt, 2 m of fine sand, and 5 m of coarse sand (Tohoku Regional Construction Bureau, MoC, unpublished data; Hase, 1967). Bedrock lies at an average depth of 35 m.

8.4.3 Eai River (Site 4)

Sand boils were common in an old river channel at Site 4, on the right bank of the Eai River (Figure 8.14). A concrete block fence near this channel was cracked by lateral spreading toward the old channel bank (Figure 8.15). Damage to the dike on this side of the river was minor. Across the river from Site 4, cracks up to 80 cm deep and 10 cm wide occurred in the dike. On both sides of the river, the foundation material contains much soft clay. Some layers of silt and sand may also be present. It was reported that the dikes were built relatively slowly, and significant settlement took place during construction (K. Kawashima, PWRI, oral communication).



Figure 8.2 Site 1, Natori River, view downstream (southeast) along repaired portion of dike. Dike is made of compacted sand. It rises 2 m above the high water level of the river and has side slopes of 2H:1V. Natori River in center-left background.

Figure 8.3 Site 1, Natori River. Slumping of dike on flank away from river. View north. (Photo courtesy Tohoku Regional Construction Bureau)



Figure 8.4 Site 1, Natori River--cracking, settlement, slumping, and lateral spreading induced by liquefaction. (From Tohoku Regional Construction Bureau, MOC, unpublished data)

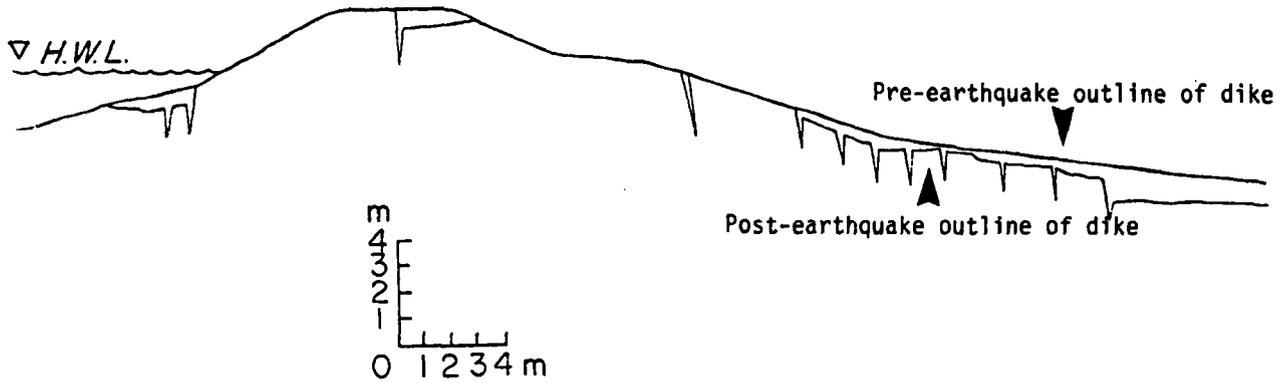


Figure 8.5 Site 1, Natori River. Liquefaction-induced cracks and sand boils in ground between river and dike indicate that liquefaction took place in materials beneath the dike. Sand in center-ground to left of crack is from sand boil. Sand bags on dike were placed after the earthquake as a repair measure. View is south.





Figure 8.6 Site 2, Natori River. View is west along repaired portion of dike. Note patch across offset in retaining wall offset caused by lateral spreading during earthquake. Retaining wall rises approximately 1 m above roadway.

Figure 8.7 Site 2, Natori River. Settlement, lateral spreading, and longitudinal cracking of dike. View is east.
(Photo courtesy Tohoku Regional Construction Bureau)





Figure 8.8 Site 2, Natori River. View is west across tributary of Natori River. Dike section shown in Figs. 8.6 and 8.7 is to right of houses in background of this figure. Note crack in concrete pavement in foreground is aligned with crack in retaining wall in background.

Figure 8.9 Site 2, Natori River--Retaining wall moved laterally and dike crest settled (From Tohoku Regional Construction Bureau, MOC, unpublished data)

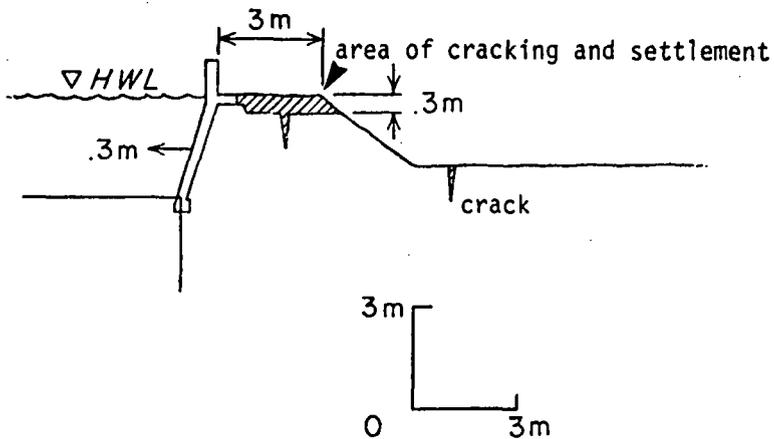




Figure 8.10 Site 3, Yoshida River. View east (downstream) along section of dike where repairs are underway. Dike crest settled as much as 1 m over a length of 5 km. Sand bags have been placed as part of repair process.

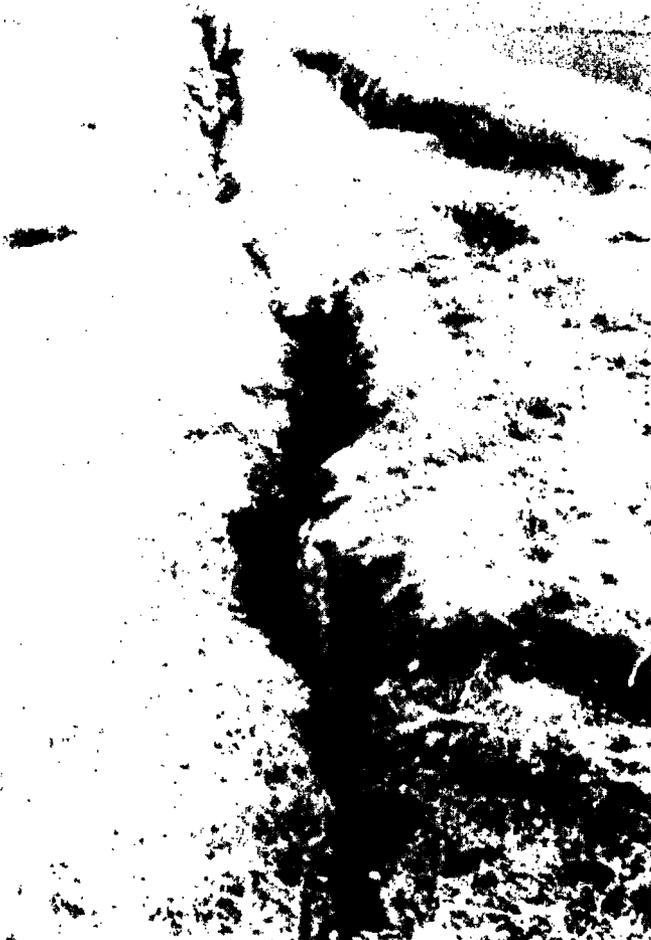


Figure 8.11 Site 3, Yoshida River. Cracks in dike caused by slumping and lateral spreading. Cracks are 10-30 cm wide. View is west. (Photo courtesy K. Kawashima, PWRI)

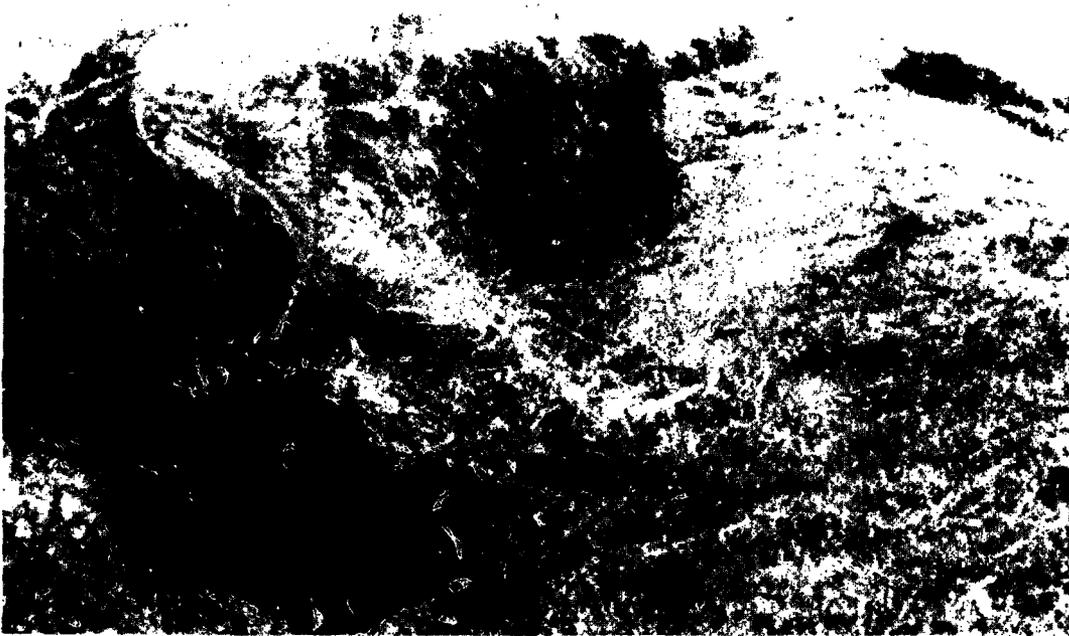
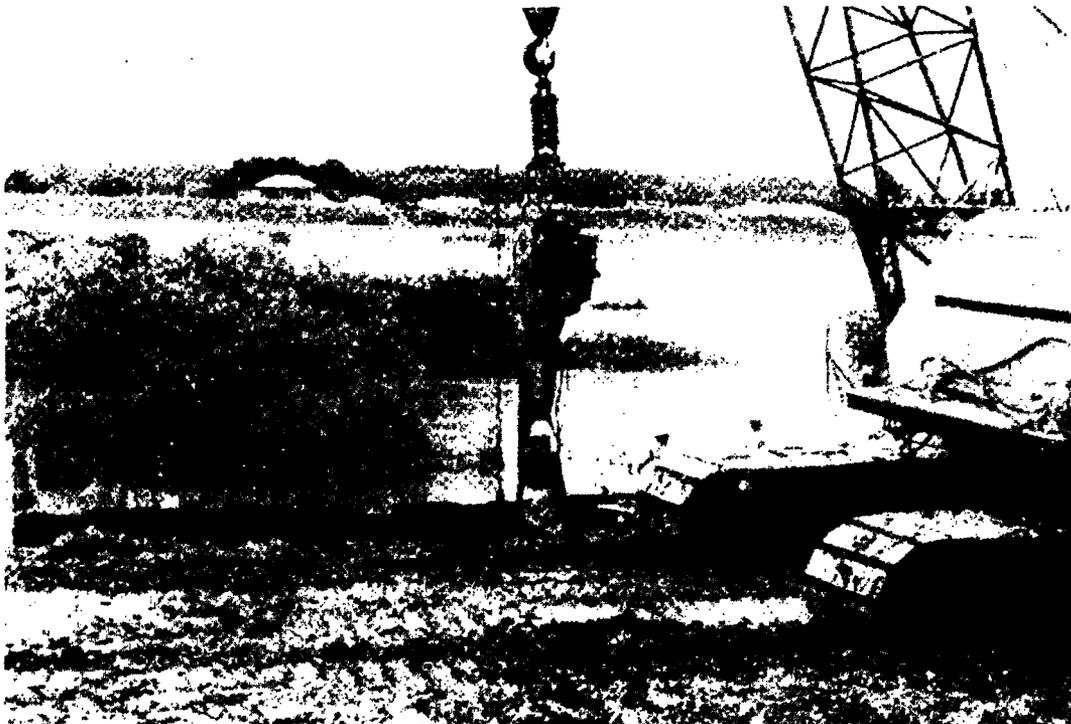
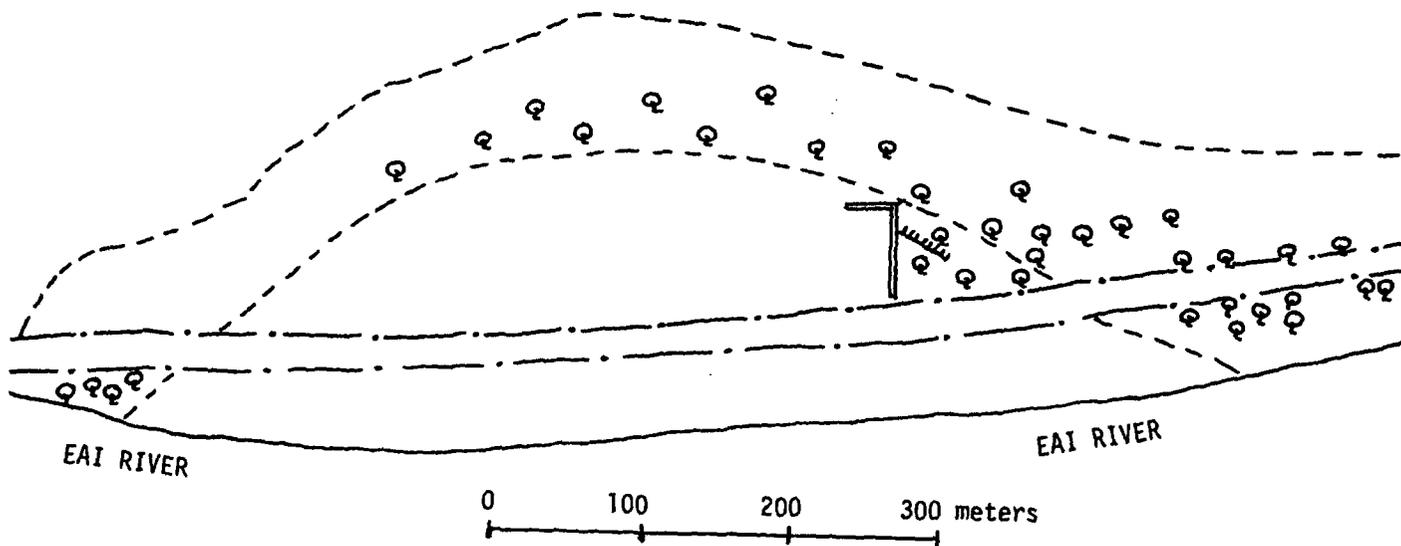


Figure 8.12 Site 3, Yoshida River. Scarps in dike caused by slumping. Note man in background for scale. (Photo courtesy K. Kawashima, PWRI)

Figure 8.13 Site 3, Yoshida River. Steel sheet piles being placed by vibratory driver as part of repair process. Purpose of sheet piles is to reduce seepage under part of dike weakened by earthquake.

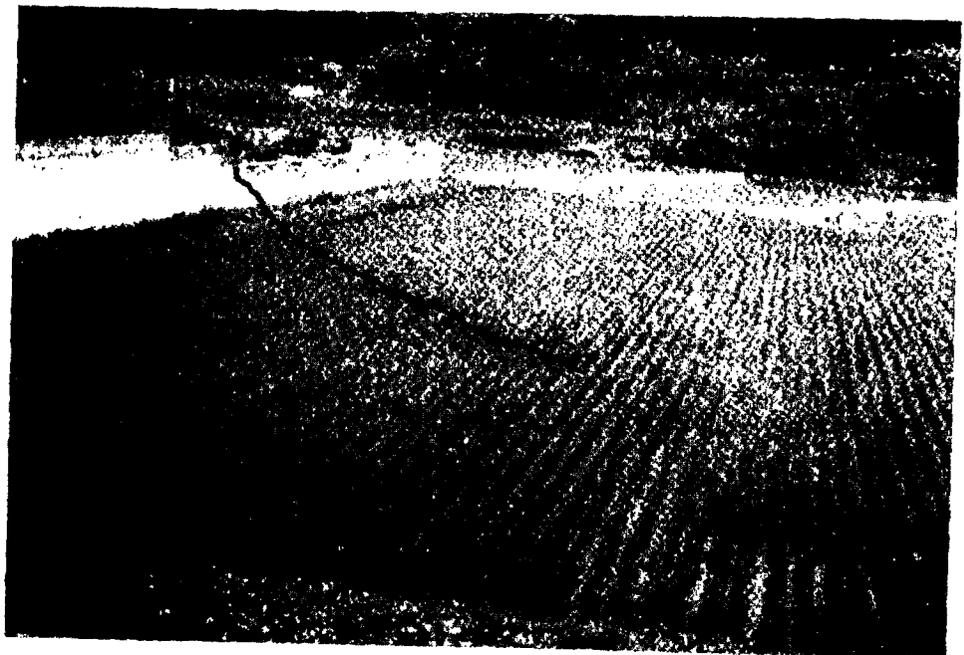




- LEGEND
- ⊙ Sand boil
 - :— Dike
 - - - - Old river channel
 - ~~~~~ Ground crack caused by lateral spreading
 - ⊥ Concrete block fence

Figure 8.14 Site 4, Eai River--Most sand boils occurred in old river channel. Minor cracking of dike apparently occurred where dike crosses old channel, but cracks were repaired prior to visit. (After Tohoku Regional Construction Bureau, MOC, unpublished data)

Figure 8.15 Site 4, Eai River - View southwest from crest of dike. Crack (indicated by heavy line) in fence and rice field caused by lateral spreading toward bank of old channel in background.



8.4.4 Old Kitakami River (Site 5)

Sand boils occurred in the rice field adjacent to the dike (Figure 8.16), but damage to the dike itself was apparently minor. Subsurface material at Site 5 consists of alternating layers of silty sand and clay to a depth of 15 m. (T. Tazaki, PWRI, oral communication).

8.4.5 New Kitakami River (Site 6)

The dike and paved roadway at Site 6 settled up to 1.5 m and cracked over a distance of 4 km (Figures 8.17 and 8.18), and sand boils formed on both flanks of the dike, which is built over an old river channel. According to data from borings completed by the Tohoku Regional Construction Bureau, MoC, the soil under the damaged part of the dike is similar to the soil under an adjacent, undamaged section. To a depth of 8 in, the soils consist of gravels, sands, and silts with a few thin layers of clay. N-values (blows/foot from a standard penetration test) for most soil layers under both sections are less than 10. Reasons for the differences in behavior between damaged and undamaged sections are currently under study by Japanese engineers.

8.5 LIQUEFACTION IN THE PORT OF ISHINOMAKI¹

In the port of Ishinomaki, a fine-sand fill liquefied, causing severe damage to anchored steel-sheet-pile bulkheads. The fill material had been dredged from the seafloor and placed hydraulically with no compaction. It was placed next to old beach deposits, and the boundary of the liquefaction damage followed the contact very closely; the beach deposits were not involved in the liquefaction.

8.6 CONCLUSION

The Miyagi-ken-oki earthquake caused cracking, settlement, lateral spreading, and slumping of man-made dikes along several rivers in the prefecture. Most of the damage was due to liquefaction. A total of 28 linear km of dikes were damaged, and total damage to dikes and other river works was approximately \$50 million. Liquefaction also occurred in hydraulic fill composed of fine sand in the port of Ishinomaki. These effects are currently being investigated by several Japanese scientists and engineers; some reports have already been published (Yoshimi and others, 1978; Okubo and Ohashi, 1979; Tatsuoka and others, 1979; Yamamura and others, 1979), and other reports should be forthcoming in the near future.

8.7 REFERENCES

1. Geological Survey of Japan, 1968, Hydrogeological Map of the Coastal Region of Bay of Sendai. Hydrogeological Maps of Japan 16, 1 map, scale 1: 100,000.
2. Geologic Map of Miyagi Prefecture, scale 1: 200,000 (legend in Japanese).
3. Hase, Kotaro, 1967, Geology of the Alluvial Plains of Miyagi Prefecture (in Japanese with English figure captions), Contributions from the Institute of Geology and Paleontology, Tohoku University, No. 64, 45 p.
4. Okubo, T., and Ohashi, M., 1979, Miyagi-ken-oki, Japan earthquake of June 12, 1978, general aspects and damage, Report distributed at 2nd U.S. National Conference on Earthquake Engineering, Stanford, California, 15 p. (In English)
5. Tatsuoka, F., Ohkochi, Y., Fukushima, S., Igarashi, H., and Yamada, S., 1979, Soil liquefaction and damage to soil structure during the earthquake off Miyagi Prefecture on June 12, 1978, Institute of Industrial Science, University of Tokyo, Bulletin of Earthquake Resistant Structure Research Center, No. 12, p. 3-13. (In English)
6. Yamamura, K., Iwasaki, T., Sasaki, Y., Koga, Y., Taniguchi, E., and Tokida, K., 1979, Ground failures and damage to soil structures from the Miyagi-ken-oki, Japan earthquake of June 12, 1978, Report distributed at 2nd U.S. National Conference on Earthquake Engineering, Stanford, California, 16 p. (In English)
7. Yoshimi, Y., Tohno, I., and Tokimatsu, K., 1978, A report on the Miyagi-ken-oki, Japan, earthquake of June 12, 1978: Part II: Geotechnical aspects of damage, International Conference on Microzonation, 2nd, San Francisco, Proc., v. 1, p. 600-605. (In English)

¹ Data kindly provided by Mr. Hajime Tsuchida, Chief, Earthquake Resistant Structures Lab, Port and Harbor Research Institute, Ministry of Construction.



Figure 8.16 Site 5, Old Kitakami River - Sand boils in rice field. Plants are several centimeters tall. Damage to the dike at this site was minor. (Photo courtesy K. Kawashima, PWRI)

Figure 8.17 Site 6, New Kitakami River. View east along crest of dike and highway that are being repaired. Uneven nature of highway surface is due to liquefaction-induced differential settlement. Settlements of up to 1.5 m occurred along a distance of 4 km.





Figure 8.18 Site 6, New Kitakami River. Cracking of dike crest and roadway due to liquefaction-induced slumping. (Photo courtesy K. Kawashima, PWRI)

9. SEISMIC-INDUCED LANDSLIDES*

9.1 INTRODUCTION

Several thousand landslides were triggered by the June 12, 1978, Miyagi-ken-oki earthquake. Landslides were concentrated within Miyagi and northern Fukushima Prefectures. The landslide distribution was densest along the coast nearest the epicenter from Sendai northeast to the area around Matsushima. Landslides were responsible for 1 death, 1 injury, 2 houses destroyed and 13 houses damaged (Y. Tsuruya, 1978, unpublished data; Tohoku University report, 1979).

Small rock falls and rock slides issuing from steep slopes were the most abundant landslides. Along the mountainous roads of the Ojika Peninsula, these landslides were generally less than 10 m³ in volume and occurred in closely fractured Triassic and Jurassic slate and interbedded quartzite. The largest contained several thousand cubic meters of debris and occurred on natural slopes in tuffaceous deposits near Matsushima and eastward on slopes near the mouth of the Naruse River (Figure 9.1).

Although fewer in number, rotational slumps in artificial fill were larger than most rock falls and slides and caused significant damage to highways and buildings. Such slumps within the city limits of Sendai were responsible for damage and destruction to houses. The poor seismic performance of fills indicates that they could be hazards in future earthquakes.

The author spent approximately three days surveying seismic-induced landslides and their effects from south of Sendai along the Natori River to the mouth of the New Kitakami River. Data included within this report comprises observations from the author's reconnaissance, information provided by Mr. Y. Tsuruya of the Japanese Ministry of Construction, and data from a report published by Tohoku University (1979).

The following descriptions of seismic-induced landslides are presented at site observations (referring to Figure 9.1 for locations of individual landslide sites and local geography). The landslide sites depict noteworthy and representative examples of the different kinds of landslides that occurred in this earthquake. Sites 1 and 4 through 8 are described with the aid of supplemental data and photographs provided by Mr. Y. Tsuruya of the Slope Protection Division, Ministry of Construction, Tokyo.

9.2 ROCK FALLS AND ROCK SLIDES ON NATURAL SLOPES

9.2.1 Site No. 1

Two of the largest rock falls from the earthquake occurred near Takayamashita in Matsushima town west of the Takagi River on steep (greater than 45°) natural slopes. The larger of these rock falls (Figure 9.2) occurred in a deeply weathered and closely jointed Miocene tuff breccia (Geologic Map of Miyagi Prefecture) exposed in a 45-m scarp. The slope affected is approximately 110 m wide, and the volume of debris is about 6,000 m³. The rock fall damaged four houses built next to the slope. A close view of some of the damage to the house second from the left in Figure 9.2 is shown in Figure 9.3.

About 0.5 km to the north, a smaller rock fall occurred on a steep slope in dark brown volcanic rocks (Miocene tuffs (?)). The scarp is about 20 m high and about 50 m wide (Figure 9.4). The debris is blocky and includes boulders up to 2 m in diameter. The scarp reveals extensively fractured bedrock. The fractured surfaces probably provided planes of weakness along which the rock failed.

9.2.2 Site No. 2

Three rock falls occurred on steep east-facing bluffs flanking a broad flood plain near the mouth of the Naruse River. All three were narrow failures, about 15 m wide, that occurred in dark brown volcanic rock similar to the smaller rock fall at Site No. 1. The slides extended from near the crest of the bluffs to the base, a height of approximately 30 m. Two of the slides are shown in Figure 9.5.

* Prepared by Edwin L. Harp, U.S. Geological Survey, Menlo Park, California.

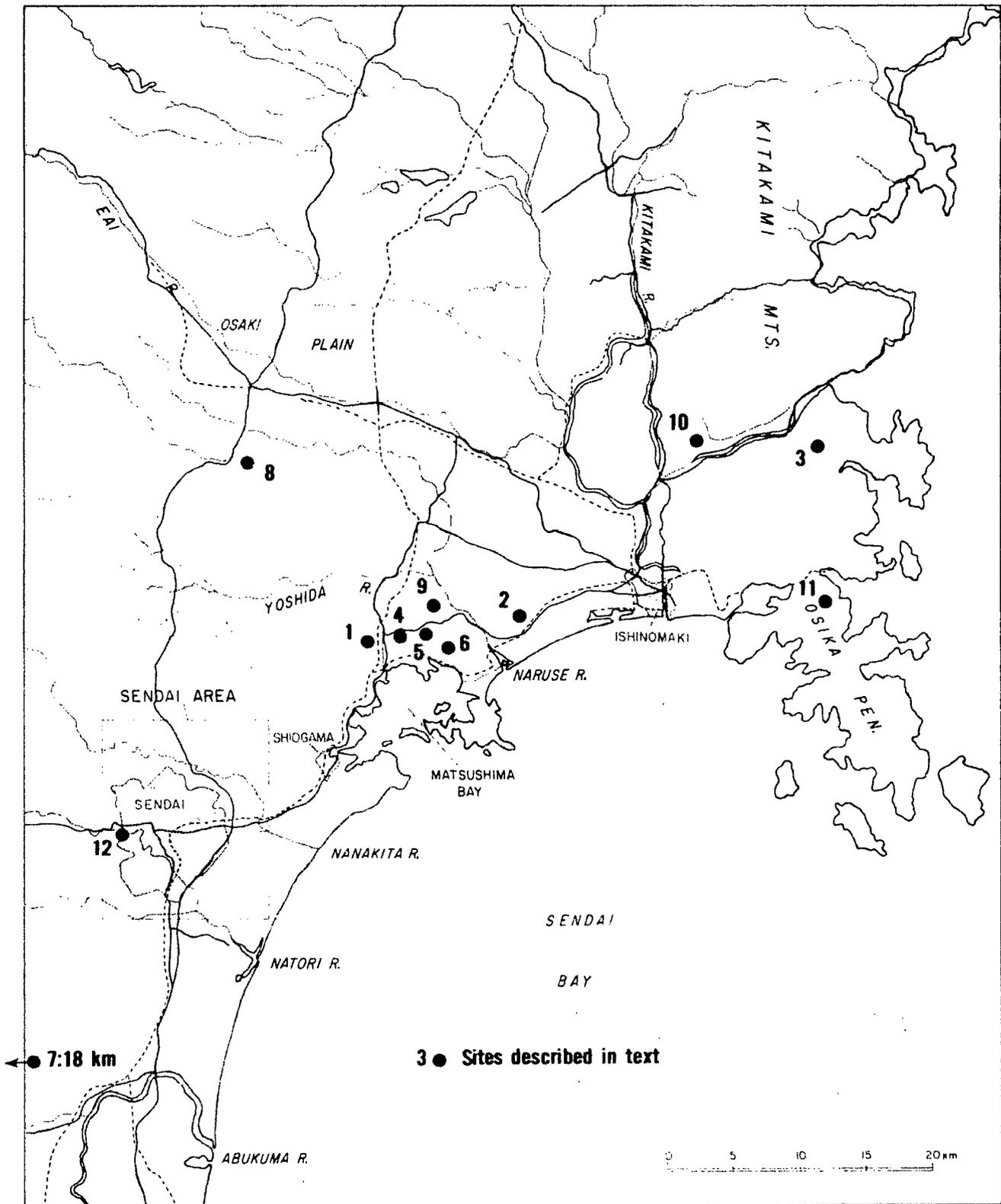


Figure 9.1 Sendai area showing sites of landslides described in text (dots).



Figure 9.2 Rock fall on steep slopes of Miocene pumiceous tuff breccia near Takayamasuita. This rock fall damaged four houses close to the base of the slope. (Photograph courtesy of Y. Tsuruya, Slope Protection Division, Ministry of Construction).

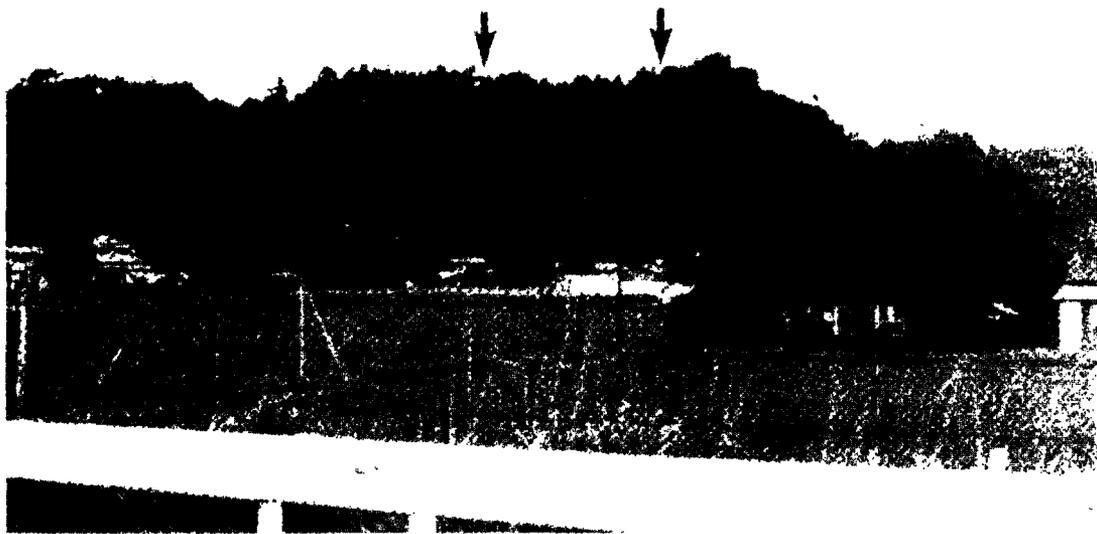
Figure 9.3 Closeup of rock fall damage to houses shown in left portion of figure 9.2. (Photograph courtesy of Y. Tsuruya)





Figure 9.4 Rock fall on steep slopes in volcaniclastic sediments.

Figure 9.5 Rock falls (arrows) in steep bluffs bordering flood plain near mouth of Naruse River.



9.2.3 Site No. 3

A small rock fall south of the New Kitakami River occurred on the end of a narrow ridge of Triassic slate and quartzite. Slopes adjacent to this end of the ridge showed no failure, suggesting that this point, which was the narrowest part of the ridge, experienced stronger shaking than adjacent slopes. This phenomenon has been documented in other earthquakes (Bonilla, 1959; Nason, 1971; Harp and others, 1978) and has been attributed to the topographic focusing of seismic energy.

9.3 ROCK FALLS AND ROCK SLIDES IN CUT SLOPES

9.3.1 Site No. 4

Near Atago in Matsushima, approximately 1.0 km east of the Site No. 1, rock falls from tuff, similar to the tuff forming the larger rock fall at Site No. 1, damaged outbuildings near three houses. About 500 m³ of debris was shaken from cut slopes 15 m in high beneath which houses and storage buildings were closely juxtaposed (Figure 9.6). Most of the damage was not to the houses proper but to attached storage sheds and outbuildings as shown in Figure 9.7.

9.3.2 Site No. 5

Approximately 3 km east of Atago in Mototetaru, Matsushima, small rock falls occurred in tuff-breccia deposits, damaging several storage buildings adjacent to houses. Failures occurred along a section of cut slope about 100 m in long and produced about 200 m³ of debris. The slope is 10-13 m high and is inclined at about 60°. One rock fall and a scarp exposing tuff breccia is shown in Figure 9.8.

9.3.3 Site No. 6

At Kakinoura in Matsushima, about 100 m³ of blocky debris was produced by a seismic-induced rock fall in tuff that damaged a concrete wall adjacent to a house. This rock fall occurred on the nose of a narrow ridge of about 35 m local relief. The slope failed along pre-existing fractures or joints and produced blocks of debris as long as 1.0 m. The size of the blocks reflects the fracture spacing of the rock. The rock fall and the house adjacent to the damaged concrete wall are shown in Figure 9.9. Two other small rock falls nearby did minor damage to walls of three other houses.

9.3.4 Site No. 7

At Kitashionai, Murata, 25 km southwest of Sendai, another steep slope in tuff failed, generating a small rock fall damaging one house. Figure 9.10 shows several houses near the nearly vertical cut slope about 15 m high. One of these houses suffered damage to a retaining fence and part of the roof. A closeup of the rock fall and roof damage is shown in Figure 9.11.

9.3.5 Site No. 8

A rock fall of approximately 1000 m³ occurred at Hebinumayama, Sanbongi, on a 20 m high, 110 m long, nearly vertical cut-slope no more than 10 m from five houses at the base of the slope (Figure 9.12). The falling rock did minor damage to two houses and attached storage sheds (Figure 9.13). Rock fall occurred along the entire length of the slope which is composed of a bedded tuff containing numerous fractures. Here, as at Kakinoura, failure took place along the pre-existing fracture surfaces. Block size of the debris ranged from several centimeters to several meters.

9.3.6 Site No. 9

A typical roadcut failure (Figure 9.14) was derived from weakly cemented sandstone along a valley west of the Naruse River. The rock fall is less than 1 m thick, and slope height is about 10 m.



Figure 9.6 Panoramic view of houses damaged by rock fall from adjacent cut slope in tuff*. Rightmost arrow points to area shown in figure 9.7. (Photograph courtesy of Y. Tsuruya).

* Arrows point to failure scarps.

Figure 9.7 Closeup of rock fall and damage to buildings shown in right-hand portion of figure 9.6. (Photograph courtesy of Y. Tsuruya)





Figure 9.8 Rock fall from steep slope in pumiceous tuff breccia near Mototataru. Failure was about 200 m³ in volume. (Photograph courtesy of Y. Tsuruya)

Figure 9.9 Rock fall in Miocene tuff causing damage to concrete wall adjacent to house. (Photograph courtesy of Y. Tsuruya)



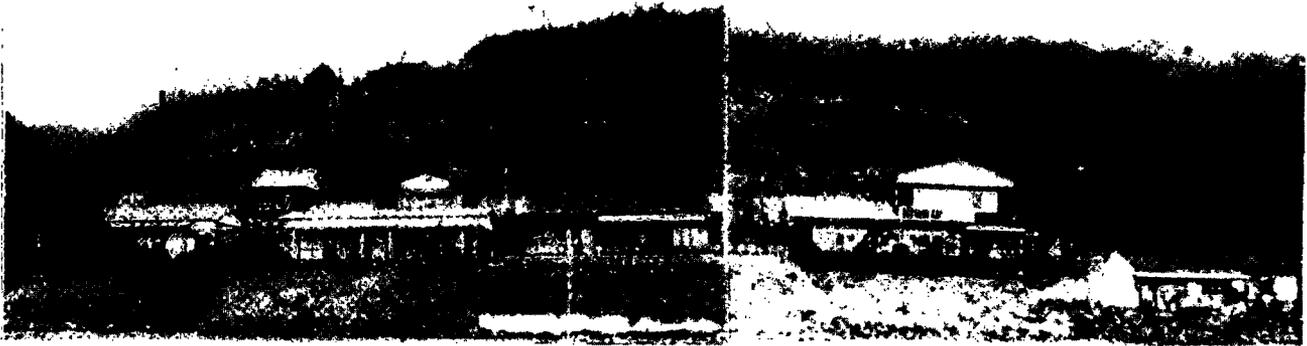


Figure 9.10 Panorama of cut slope near Kitashiona in Miocene tuff which produced rock falls during earthquake damaging nearby houses. Arrow points to damaged house shown in closer view in figure 9.11. (Photograph courtesy of Y. Tsuruya)

Figure 9.11 Rock fall damage to retaining wall and roof of house in left-hand portion (arrow) of figure 9.10. (Photograph courtesy of Y. Tsuruya)





Figure 9.12 Steep slope near Hebinumayama in heavily fractured tuff which underwent failure as rock falls damaging portions of houses in front of the slope.

Figure 9.13 Rock fall from slope shown in figure 9.12 impinging on storage shed next to slope.

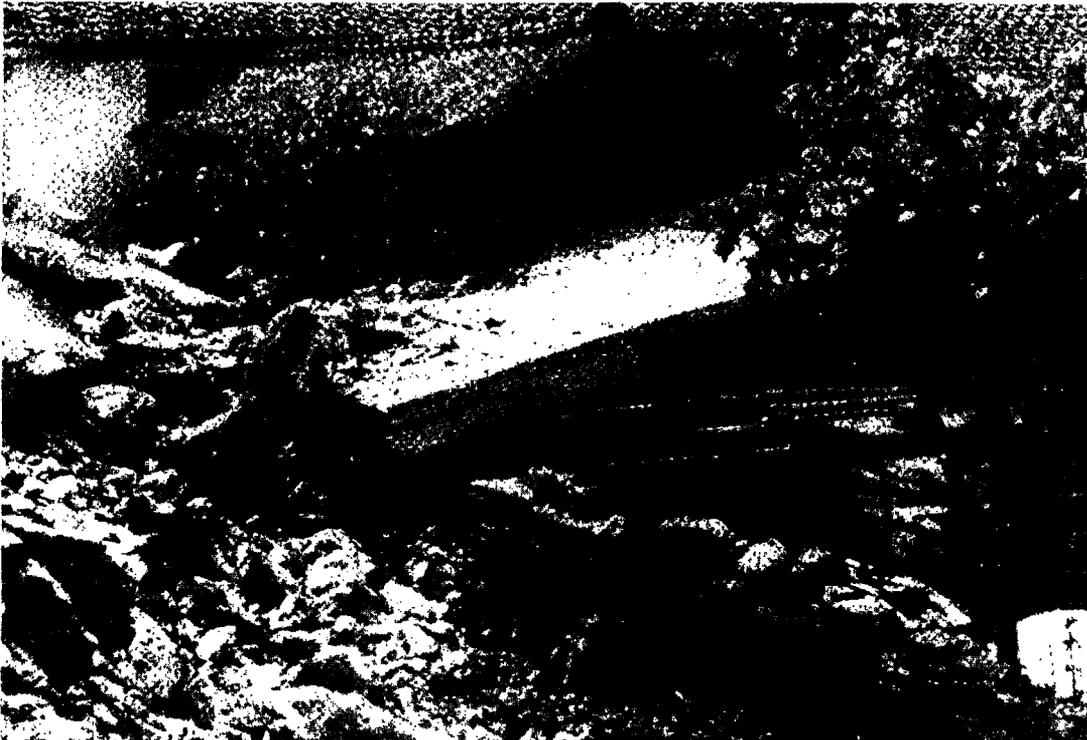




Figure 9.14 Rock fall from roadcut in weakly cemented sandstone.

9.3.6 Site No. 10

A rock fall in Triassic slate and fine-grained quartzite occurred on a steep roadcut slope on the north side of the New Kitakami River. The scarp of the rock fall is inclined at about 60° and is formed by prominent slaty cleavage planes (Figure 9.15). The blocky debris broke into pieces of up to 30 cm in longest dimension. Almost all of the debris consisted of blocks that had separated along pre-existing fractures.

9.3.7 Ojika Peninsula

Reconnaissance of the Ojika Peninsula and area immediately to the north was along winding mountain roads that traversed heavily vegetated slopes. The slopes had a thin soil mantle, generally less than 0.5 m thick. Numerous small rock falls were derived from the near vertical roadcuts in these slopes. None contained more than a few cubic meters of debris.

9.4 LANDSLIDES IN ARTIFICIAL FILL

9.4.1 Site No. 11

Several artificial fill failures occurred on roads on the Ojika Peninsula; one such failure is shown in Figure 9.16. The fill material slumped away from beneath the road surface and formed a scarp cutting about 2 m into the highway. The fill appeared to be either uncompacted or poorly compacted sandy clay derived from adjacent bedrock and soil. This failure occurred at a site where rainfall-induced slumping had occurred repeatedly before the earthquake (T. Tazaki, 1978, oral communication). At the time of the visit, plastic sheets had been spread over the extensively cracked pavement to prevent or minimize rainfall infiltration into the scarp area. During observation, heavy rainfall was mobilizing the debris into small mudflows.

9.4.2 Site No. 12

Many slope failures in artificial fill took place within the city limits of Sendai. These failures were mainly slumps. In the neighborhood of Midorigaoka, a large rotational slump occurred in a fill slope of about 15° , composed of gravelly clay. From the headwall scarp to toe, the slump extends approximately 70 m horizontally and 20 m vertically (Y. Matsuzaki, 1978, unpublished data); it is approximately 30 m wide and about 14 m in maximum thickness, thus the approximate volume is $30,000 \text{ m}^3$. Most of the slump was above and to the right of one of the 1400 concrete slope-protection dams (sabo works) in Sendai (Figure 9.17). The slump-mass had been covered with nylon tarps before the photograph was taken to prevent infiltration of rainfall.

Many houses had been removed from this slope in previous years due to rainfall-induced slumping; as a result, only one house near the headwall scarp was severely damaged by the seismic-induced sliding. Figure 9.18 shows this house, which was being undercut by the multiple scarps at the head of the slump. The fence in the figure shows the rotational component of slump movement.

About 5 m of horizontal displacement (Y. Matsuzaki, 1978, unpublished data) occurred, placing the toe of the landslide mass only a few meters from houses below. One such house, which had been evacuated because of the threat of recurrent movement is shown in Figure 9.19.

At the time of observation, engineers from the Sabo Section of the Miyagi Prefectural government were engaged in a geotechnical investigation of the slump mass and surrounding area. Boreholes had been drilled in the slide material to establish the depth of the failure surface, to provide samples for strength testing, and to emplace slope inclinometers to monitor any continuing movement. Adjoining areas were also being drilled and monitored to detect any movement that might be precipitated by the slide, such as deformation downslope from the toe in response to the weight of the encroaching slide mass or retrogressive slumping upslope from the headwall scarp.

Many other artificial fill slopes in Sendai underwent similar failure. At a site about 0.5 km east of Midorigaoka, six houses were condemned by the mayor of Sendai because of cracking



Figure 9.15 Rock fall in roadcut. Note slaty cleavage planes that form the rock fall scarp.

Figure 9.16 Slump in artificial fill along a highway on the Ajika Peninsula.

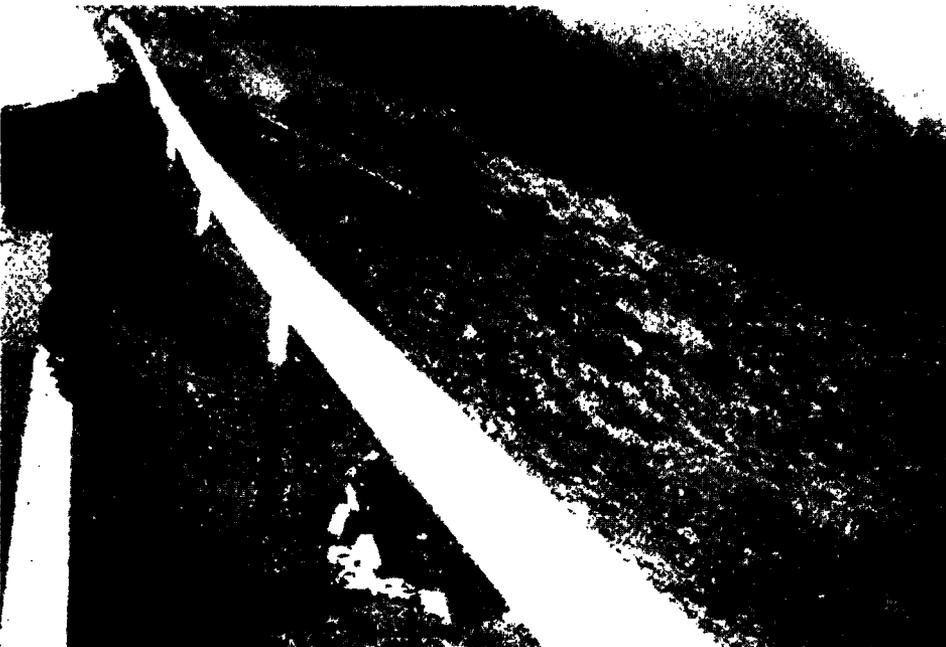




Figure 9.17 Rotational slump in artificial fill in Sendai (area covered by tarps) which destroyed one house and is threatening others. To left of slump is concrete slope protection dam (sabo works).

Figure 9.18 House near head of slump. House was removed due to undercutting by headwall scarp (Photograph courtesy of Y. Tsuruya).

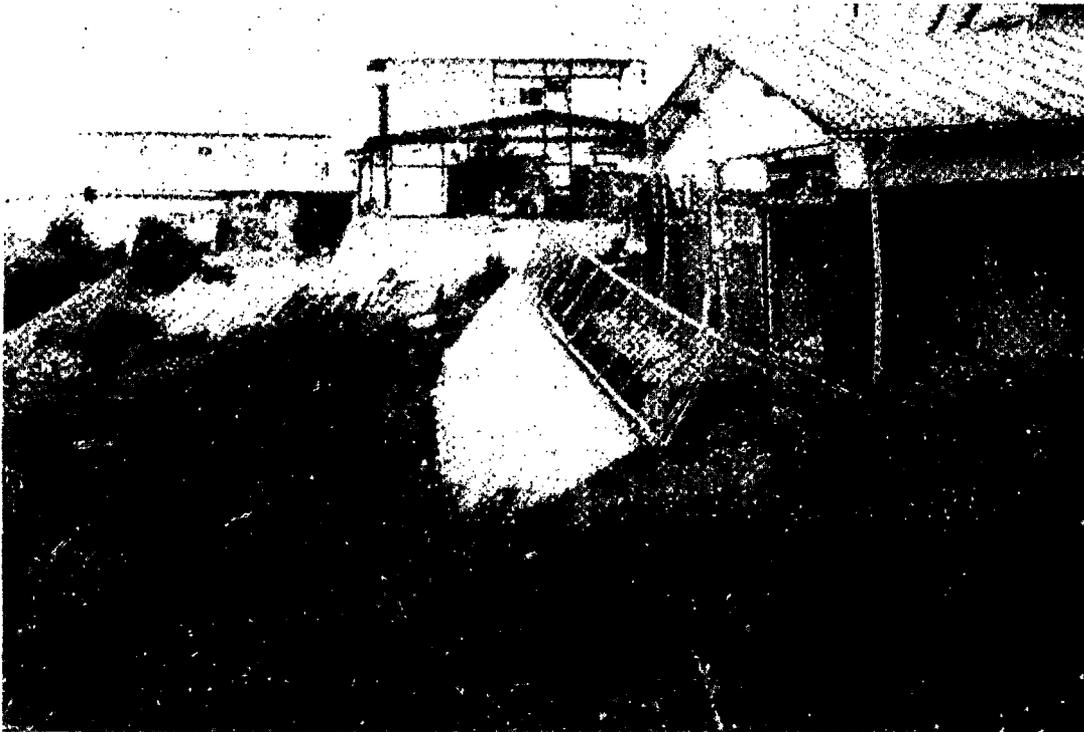




Figure 9.19 Toe of slump and house below in danger of being overridden by slide mass. House has been evacuated.

beneath and around the houses within the fill area. The decision to destroy the houses was made to protect the houses downslope because the failure of the slope was judged to be imminent unless the weight of the damaged houses was removed (T. Tazaki, 1978, oral communication).

A large, spectacular slump in artificial fill, derived from Miocene ash-flow tuff, occurred in Shiroishi City, about 35 km southwest of Sendai. One fatality occurred from this failure. This slump took place in a planned residential area under conditions of a high water table. The slump movement was accompanied by mudflow (Tohoku Univ. report, 1979). This landslide was not seen by the author, but is described by the Tohoku University report (1979).

Judging from the extensive failure of artificial fill slopes, as compared to the few noticeable landslides on the many steep natural slopes in the same areas, the artificial fill is particularly susceptible to seismic-induced failure. These artificial-fill slopes are likely to be hazards in future earthquakes.

9.5 SUMMARY OF FINDINGS

The June 12, 1978, Miyagi-ken-oki earthquake triggered several thousand landslides in Miyagi and Fukushima Prefectures. A field reconnaissance of the coastal region nearest the epicenter two weeks after the earthquake led to the following general findings:

(1) Most landslides were rock falls and rock slides and occurred on natural and cut slopes steeper than 45°. Damage to houses and other structures was a result of the close proximity of houses to the base of steep slopes.

(2) Many slopes and roadways constructed on artificial fill failed during the earthquake. The slumping of artificial slopes also caused extensive damage to houses. The heaviest damage from these failures occurred in areas occupied by housing developments in Sendai and in Shiroishi.

(3) Many slopes composed of artificial fill were more susceptible to seismic-induced failure than steep natural slopes. This susceptibility is probably a result of insufficient compaction of the fill material. Artificial fill slopes could constitute a significant hazard in future earthquakes.

9.6 REFERENCES

- 9.1. Bonilla, M. C., 1959, Geologic observations in the epicentral area of the San Francisco earthquake of March 22, 1957, in Oakeshott, G. B., ed., The San Francisco earthquake of March 1957: California Division of Mines Special Report No. 57, p. 25-37.
- 9.2. Geologic Map of Miyagi Prefecture, legend in Japanese.
- 9.3. Harp, E. F., Wiczorek, G. F., and Wilson, R. C., 1978, Earthquake-induced landslides from the February 4, 1976 Guatemala earthquake and their implications for landslide hazard reduction: International Symposium on the February 4, 1976 Guatemalan Earthquake and the Reconstruction Process, Guatemala City, Proceedings.
- 9.4. Nason, R. D., 1971, Shattered earth at Wallaby Street, Sylmar, in the San Fernando, California earthquake of February 9, 1971: U.S. Geological Survey Prof. Paper 773, p. 97-98.
- 9.5. Tohoku University Report, 1979, Phenomena and disasters associated with the Miyagi-ken-oki earthquake of 1978 in the East-central part of Northeast Honshu, Japan: Institute of Geology and Paleontology, Tohoku University, no. 80, 97p., 34 figs., 2 tables, 7 pls., (summary and captions in english).

10. GENERAL CONCLUSIONS

The effect of the Miyagi-ken-oki earthquake of June 12, 1978 on the Sendai area was quite moderate, considering its magnitude and the potential for disaster. This was in large measure due to good engineering practice and the extremely quick and comprehensive response of the Japanese authorities to the earthquake. At the time of the team investigation beginning 11 days following the earthquake, much of the debris had been cleared away and repair and recovery operations were well underway. The approaching rainy season gave a sense of urgency to these tasks. With the exception of a few establishments still without city gas service, the situation in Sendai was essentially normal. It was obvious that the response to the earthquake was well planned and that the disaster mitigation and relief activities are well coordinated among the different levels of government. The fact that the main energy release occurred some distance from any inhabited areas lessened the impact that an earthquake of this magnitude otherwise would have had.

Subsequent investigation showed that modern structures and facilities suffered little damage. In particular, structures designed subsequent to the promulgation of the new seismic design provisions of 1971 performed exceedingly well. The successful performance of most modern multistory buildings shows that modern seismic engineering practices can provide resistance to strong earthquake motions at reasonable cost. The total damage due to Miyagi-ken-oki earthquake constituted a small percentage of the total capital investment in buildings and structures, despite recorded ground accelerations in the range 0.25g - 0.40g in the Sendai area, and accelerations as high as 1.0g in upper stories of high rise buildings.

Numerous pockets of damage existed throughout the city that apparently were correlated to the local geology and soil conditions. Acceleration magnitudes across Sendai varied considerably with location. The eastern part of the city, where many of the damaged structures were located, is built on alluvial deposits which, from a foundation standpoint, are poorer than the remaining portion of the city. Soil conditions in the central portion of Sendai are considerably better, and the damage was limited.

Analyses of the earthquake and the performance of structures are currently being conducted or recently have been completed by Japanese engineers and seismologists. One of the first of these is the report on strong motion records and data issued by the Strong Motion Earthquake Observation Council, National Research Center for Disaster Prevention of Japan. Digitization of some of the traces has been performed by the Building Research Institute and Public Works Research Institute. Tokyo Electric Power Company engineers are conducting a comprehensive analysis of the strong motion data gathered at the Fukushima nuclear power plant. When this information is released, probably within the next year or so, it will be of considerable value to engineers and licensing officials in the U.S. as well as Japan. These reactors and containments are similar to those operating in the U.S. and they suffered no damage in the earthquake.

Although similar observations have been made in the aftermath of previous earthquakes, it seems worthwhile to reemphasize the following points about achieving earthquake resistant design:

- (1) Structure should be laid out so that they are as symmetrical as is consistent with their function. Practically all severely damaged or collapsed engineered structures exhibited a significant asymmetry of some kind in the form of an eccentric mass or placement of shear walls.
- (2) When infill panels or spandrels are used, particular attention should be paid to detailing and to the design of structural members connected to them. When used on only one side of a building, their stiffening effect causes most of the damage to occur to that side.
- (3) The apparent correlation of structure damage to local soil and geologic conditions suggests that this factor should receive additional attention in the design of structures of even moderate size and cost. Seismic regulations in codes should include a soils parameter in their load criteria.
- (4) Performance of buildings clearly is related to quality control and design detailing. There were cases of failures where column ties appeared to be minimal and improperly

anchored. In other instances, they appeared to be adequate. The question arises whether discrepancies exist between the structure as built and the code recommendations.

- (5) Post earthquake investigation of damaged bridges has taught many lessons. The 1964 Niigata and 1971 San Fernando earthquakes pointed to the importance of providing 1) restraining devices across hinges and joints and 2) proper column reinforcement details including the foundation connections. The 1976 Guatemala earthquake demonstrated that the longitudinal restraining devices across hinges can provide the continuity required to keep spans from falling. The Miyagi-ken-oki earthquake has provided incentive to further investigate the need for and performance of transverse restraining devices and to examine the philosophy behind ductile and non-ductile column/pier design. Another topic of interest is correlation of soil type to foundation/substructure damage.
- (6) The collapse of the Kin-noh bridge, which was previously damaged in a February 1978 earthquake, indicates that structural damage may occur due to either strong aftershocks or multiple event excitation.

In regions of high seismicity, critical and important structures should be identified and additional care should be taken in detail design and in field inspection (quality assurance) during construction.

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET	1. PUBLICATION OR REPORT NO. NBS SP 592	2. Gov't Accession No.	3. Recipient's Accession No.
4. TITLE AND SUBTITLE An Investigation of the Miyagi-ken-oki, Japan Earthquake of June 12, 1978		5. Publication Date October 1980	6. Performing Organization Code
7. AUTHOR(S) Bruce R. Ellingwood		8. Performing Organ. Report No.	
9. PERFORMING ORGANIZATION NAME AND ADDRESS NATIONAL BUREAU OF STANDARDS DEPARTMENT OF COMMERCE WASHINGTON, DC 20234		10. Project/Task/Work Unit No.	11. Contract/Grant No.
12. SPONSORING ORGANIZATION NAME AND COMPLETE ADDRESS (Street, City, State, ZIP) Same as item 9.		13. Type of Report & Period Covered Final	
15. SUPPLEMENTARY NOTES Library of Congress Catalog Card Number: 80-600116 <input type="checkbox"/> Document describes a computer program; SF-185, FIPS Software Summary, is attached.		14. Sponsoring Agency Code	
16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.) <p>On June 12, 1978, a destructive earthquake with Richter magnitude of 7.4 occurred off the east coast of Miyagi Prefecture, Japan. Preliminary estimates by the National Land Agency of Japan indicated that the earthquake caused an equivalent of \$800 million in total damage. There is a cooperative agreement between the Governments of the United States and Japan termed the U.S.-Japan Program in Natural Resources (UJNR). Following the earthquake, it was arranged through UJNR that teams of U.S. structural engineers and geologists would visit Miyagi Prefecture and inspect the damage caused by the earthquake. This report assembles the information and collective experiences of the investigation team so as to describe the earthquake and document its effects. Field investigations conducted by geologists and structural engineers are described in detail and some of the implications for seismic resistant design and construction of structures in the United States are also discussed.</p>			
17. KEY WORDS (six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons) Bridges; buildings; dikes; earthquakes; foreign engineering; geology; highways; housing; landslides; liquefaction; power plants; railroads; rock slides; seismicity; structural engineering.			
18. AVAILABILITY <input checked="" type="checkbox"/> Unlimited <input type="checkbox"/> For Official Distribution. Do Not Release to NTIS <input checked="" type="checkbox"/> Order From Sup. of Doc., U.S. Government Printing Office, Washington, DC 20402. <input type="checkbox"/> Order From National Technical Information Service (NTIS), Springfield, VA. 22161		19. SECURITY CLASS (THIS REPORT) UNCLASSIFIED	21. NO. OF PRINTED PAGES 232
		20. SECURITY CLASS (THIS PAGE) UNCLASSIFIED	22. Price

USCOMM-DC

NB! 0 0000 017 519 539 ATIONS

PERIODICALS

JOURNAL OF RESEARCH—The Journal of Research of the National Bureau of Standards reports NBS research and development in those disciplines of the physical and engineering sciences in which the Bureau is active. These include physics, chemistry, engineering, mathematics, and computer sciences. Papers cover a broad range of subjects, with major emphasis on measurement methodology and the basic technology underlying standardization. Also included from time to time are survey articles on topics closely related to the Bureau's technical and scientific programs. As a special service to subscribers each issue contains complete citations to all recent Bureau publications in both NBS and non-NBS media. Issued six times a year. Annual subscription: domestic \$13; foreign \$16.25. Single copy, \$3 domestic; \$3.75 foreign.

NOTE: The Journal was formerly published in two sections: Section A "Physics and Chemistry" and Section B "Mathematical Sciences."

DIMENSIONS/NBS—This monthly magazine is published to inform scientists, engineers, business and industry leaders, teachers, students, and consumers of the latest advances in science and technology, with primary emphasis on work at NBS. The magazine highlights and reviews such issues as energy research, fire protection, building technology, metric conversion, pollution abatement, health and safety, and consumer product performance. In addition, it reports the results of Bureau programs in measurement standards and techniques, properties of matter and materials, engineering standards and services, instrumentation, and automatic data processing. Annual subscription: domestic \$11; foreign \$13.75.

NONPERIODICALS

Monographs—Major contributions to the technical literature on various subjects related to the Bureau's scientific and technical activities.

Handbooks—Recommended codes of engineering and industrial practice (including safety codes) developed in cooperation with interested industries, professional organizations, and regulatory bodies.

Special Publications—Include proceedings of conferences sponsored by NBS, NBS annual reports, and other special publications appropriate to this grouping such as wall charts, pocket cards, and bibliographies.

Applied Mathematics Series—Mathematical tables, manuals, and studies of special interest to physicists, engineers, chemists, biologists, mathematicians, computer programmers, and others engaged in scientific and technical work.

National Standard Reference Data Series—Provides quantitative data on the physical and chemical properties of materials, compiled from the world's literature and critically evaluated. Developed under a worldwide program coordinated by NBS under the authority of the National Standard Data Act (Public Law 90-396).

NOTE: The principal publication outlet for the foregoing data is the Journal of Physical and Chemical Reference Data (JPCRD) published quarterly for NBS by the American Chemical Society (ACS) and the American Institute of Physics (AIP). Subscriptions, reprints, and supplements available from ACS, 1155 Sixteenth St., NW, Washington, DC 20056.

Building Science Series—Disseminates technical information developed at the Bureau on building materials, components, systems, and whole structures. The series presents research results, test methods, and performance criteria related to the structural and environmental functions and the durability and safety characteristics of building elements and systems.

Technical Notes—Studies or reports which are complete in themselves but restrictive in their treatment of a subject. Analogous to monographs but not so comprehensive in scope or definitive in treatment of the subject area. Often serve as a vehicle for final reports of work performed at NBS under the sponsorship of other government agencies.

Voluntary Product Standards—Developed under procedures published by the Department of Commerce in Part 10, Title 15, of the Code of Federal Regulations. The standards establish nationally recognized requirements for products, and provide all concerned interests with a basis for common understanding of the characteristics of the products. NBS administers this program as a supplement to the activities of the private sector standardizing organizations.

Consumer Information Series—Practical information, based on NBS research and experience, covering areas of interest to the consumer. Easily understandable language and illustrations provide useful background knowledge for shopping in today's technological marketplace.

Order the above NBS publications from: Superintendent of Documents, Government Printing Office, Washington, DC 20402.

Order the following NBS publications—FIPS and NBSIR's—from the National Technical Information Services, Springfield, VA 22161.

Federal Information Processing Standards Publications (FIPS PUB)—Publications in this series collectively constitute the Federal Information Processing Standards Register. The Register serves as the official source of information in the Federal Government regarding standards issued by NBS pursuant to the Federal Property and Administrative Services Act of 1949 as amended, Public Law 89-306 (79 Stat. 1127), and as implemented by Executive Order 11717 (38 FR 12315, dated May 11, 1973) and Part 6 of Title 15 CFR (Code of Federal Regulations).

NBS Interagency Reports (NBSIR)—A special series of interim or final reports on work performed by NBS for outside sponsors (both government and non-government). In general, initial distribution is handled by the sponsor; public distribution is by the National Technical Information Services, Springfield, VA 22161, in paper copy or microfiche form.

BIBLIOGRAPHIC SUBSCRIPTION SERVICES

The following current-awareness and literature-survey bibliographies are issued periodically by the Bureau:

Cryogenic Data Center Current Awareness Service. A literature survey issued biweekly. Annual subscription: domestic \$35; foreign \$45.

Liquefied Natural Gas. A literature survey issued quarterly. Annual subscription: \$30.

Superconducting Devices and Materials. A literature survey issued quarterly. Annual subscription: \$45. Please send subscription orders and remittances for the preceding bibliographic services to the National Bureau of Standards, Cryogenic Data Center (736) Boulder, CO 80303.

U.S. DEPARTMENT OF COMMERCE
National Bureau of Standards
Washington, D.C. 20234

OFFICIAL BUSINESS

Penalty for Private Use, \$300

POSTAGE AND FEES PAID
U.S. DEPARTMENT OF COMMERCE
COM-215



SPECIAL FOURTH-CLASS RATE
BOOK
