Preventing Natech Catastrophes: Country Practices and Case Studies of Chemical Accident Prevention during Natural Disasters

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Introduction

• Natural disasters can:
  – can down power lines,
  – cause landslides
  – damage lifeline systems
  – trigger hazardous materials (hazmat) releases
Natech disasters:

• Natural disaster-triggered technological disasters

Technological disaster:

• Release of hazardous materials (hazmat)
• Damage to oil and gas pipelines
• Damage to lifeline systems
Natechs

Releases of hazardous materials Turkey, 1999

Damage to lifeline systems Portugal, 2001

Damage to oil and gas pipelines France, 2002
Natechs in Urban Environments

Natural Hazard

Urban center

Community
Hazardous establishments
Lifeline systems

Natech disaster

Implications for urban settings
- More people and property at risk
- More complex and interdependent systems
- Increased potential for cascading events
Nature of natech risk:

Technological event

Natech event

Natech disasters pose tremendous risks to regions which are unprepared for these events

Mitigation and emergency response
Risk of natechs:

- There is limited statistical data on natechs
- A few studies indicate that natechs may be on the rise
- Natech-related release rates range from 8% to 20% during EQ*
- Hazmat releases more likely to occur from larger facilities in EQ
- Damage more likely at older industrial plants
- More frequent during earthquakes, followed by floods and storms

* Cruz and Steinberg 2005, Lindell and Perry 1997
Multiple hazmat releases more likely during natural disasters*

- 81% of natech in the US involved more than 2 hazmat releases
- 11.4% of natechs involved at least 3 hazmat releases
- 5% of natechs involved more than 4 hazmat releases

* Sengul, Steinberg and Cruz 2006
Natech disasters

- Tokachi-oki earthquake in Japan in 2003: Multiple fires at an oil refinery, nuisance to neighbouring community
- Floods in the Czech Republic in 2002: Chlorine release, results in emergency state
- Floods in southern France in 2002: Damage to industrial facilities and hazmat releases
Kocaeli earthquake in 1999

Asian-Tsunami, Banda Aceh and Somalia, 2004

Natechs

Oil spill in residential area, Hurricane Katrina
Hurricanes Katrina and Rita Impacts on Oil & Gas Industry

- A total of 2000/3000 platforms affected
- 100 oil and gas platforms completely destroyed including connected pipeline systems
- Hundreds of miles of oil and gas pipelines were displaced or broken (inland and offshore)
- In Dec 2005 over 50 % still shut down
Hurricane Katrina: hazmat releases

- Chevron, Pascagoula refinery in Mississippi – severely flooded, can not start production
- Murphy Oil, New Orleans – 85,000 bs crude oil released beyond secondary containment
- Oil refinery in metro NOLA area releases 8000 barrels, hundreds of homes affected in Chalmette, LA alone (law suits)
- Over 300 chemical facilities reported loss of containment
- Oil spills at more than 144 sites totaling over 8 million barrels
DISTRIBUTION OF OIL AND HAZMAT RELEASES IN HURRICANE KATRINA AFFECTED AREA

*Map by Ms. Hatice Sengul
Natech disasters are particularly problematic…..

- Simultaneous response efforts required to attend both natural disaster and technological disaster
- Natural disasters are likely to trigger simultaneous releases from single or multiple sources
- Lifeline systems needed for mitigation and response are likely to be unavailable
- Safety and mitigation measures designed for single (day-to-day operation) events
Natech disasters are particularly problematic.....

• Warning systems (to protect residents) may not be functional (e.g., shelter in place may not be feasible if buildings are no longer safe)

• Although safety techniques have implemented to contain hazmat accidents, they are typically not designed to accommodate releases triggered by, and simultaneous with natural disasters
Local government, community and emergency officials

Industrial safety officers often work separately from those in charge of natural disaster management

Risk management practices often do not require hazardous plants to address external risks and consequences beyond their own establishments

Lack expertise to establish risk management programs for and respond to natechs

Resulting in little or no knowledge of dangers associated with natechs
Natech risk management in USA, California, Europe, and Japan

- Are external hazards being considered?
- Are accidental hazmat releases reported?
- Do chem-hazard regulators work separately from emergency responders?
- Efforts to develop natech hazard maps?
- Land use planning requirements?
- Consideration of potential domino effects?
Chemical Accident Prevention and Natech Risk Reduction in the USA

US Environmental Protection Agency (EPA)

Chemical Accident Prevention and Risk Management

Federal Emergency Management Agency (FEMA)

Emergency Management (Natural Hazards mainly)

Local Emergency Response
US Federal Requirements

• Federal requirements for chemical accident prevention appear in a variety of programs including:

  – Process Safety Management (PSM)  
    protection of workers
  – Risk Management Plan for Accidental Chemical Releases  
    protection of the public
  – Emergency Response Program under the Emergency Planning and Community Right to Know Act  
    protection of the public
RMP rule requirements:

1. Hazard assessment
   - potential effects of an accidental release
   - worst-case & alternative accidental releases

2. Prevention program
   - safety precautions and maintenance
   - monitoring

3. Emergency response
   - emergency health care
   - employee training measures
   - procedures for informing the public/response agencies
Gaps in RMP rule requirements:

- No specific provisions to address issues related to land use planning (LUP)
- Required only for parts of plant or processes that handle hazmats
- Not all hazmats are regulated, RMP applies after certain threshold quantity
- No provisions to address potential domino effects
- No provisions to assess the risk from external hazards such as a natural disaster (e.g., hurricanes, earthquakes)
Natech Risk and Emergency Management Practices in California

- Additional hazards analysis called for in California Accidental Release Prevention (CalARP) program
- CalARP calls specifically for a risk assessment of potential releases due to an earthquake
- Even after CalARP there are gaps
Gaps in CalARP program:

- Seismic assessment not required for all processes nor for non-structural safety and mitigation measures
- Neighboring process equipment not regulated could fail leading to domino effects
- Seismic analysis of on-site utility systems is not explicitly required
- Response planning for multiple releases is not considered
Regulatory requirements (EC): Seveso II Directive

• Set up of a major-accident prevention policy
• Write and submit a safety report
• Establish emergency plans in the case of an accidental release
Regulatory requirements (EC): Seveso II Directive

Safety report:

- Identification of hazards
- Implementation of adequate safety measures
- Establish emergency plans
Regulatory requirements (EC): Seveso II Directive

- Calls for analysis of “external events”
- Calls for the analysis of potential domino effects
- Calls for land use policies (e.g., keeping safe distance between facility and community)
- Does not specify methodologies or actions that can be taken varied levels of preparedness among countries
Natech risk management in Europe*

- No provisions to mitigate or respond to natechs during concurrent natural disasters
- No provisions to insure operability of buildings, lifelines, process air, water, etc. after disaster
- No data on incidence of natechs
- Regulation of natural hazards and technological hazards as separate events
- Guidelines do not explicitly address natechs problems (e.g., loss of lifelines, lack of personnel)

*EC, Italy, Bulgaria, France, Germany, Portugal and Sweden*
Natech risk management in Europe*

- Evidence of heightened awareness of natech issues, about half felt that there was a 50% chance of a natech
- Still not sufficient reflection of this in laws of individual countries
- No provisions to prevent or respond to simultaneous releases from single or multiple sources

*EC, Italy, Bulgaria, France, Germany, Portugal and Sweden*
Learning from past in Europe

- Recent natech experiences have occurred in nearly all the participating countries.
- France has revised its Environmental Code to reflect the lessons learned from floods in 2002.
- Germany is studying flood hazards in Saxony and Saxony-anhalt as well as launching a new country-wide risk study to assess the risk of unusual dangers such as natechs.
Lessons learned in Europe

- Italy is concerned with possible natechs caused by flooding on the Arno River and has completed a prototype plan to protect against such accidents
- Italy is reviewing industrial accident regulations to include natech (in co-operation with OEDC)
- Portugal, after guarding against a threatened natech involving a gas pipeline, has recognized the need to plan for natech risks
Risk management in Japan

Chemical accident prevention regulated by a many laws including:
1. High Pressure Gas Control Law
2. The Labor Safety and Hygiene Law
3. The Petroleum Complex Disaster Prevention Law
4. Fire Service Law
Risk management in Japan

• Laws apply to industrial facilities that handle high pressure gases and other hazmats, as well as petroleum industry

• Requires establishing maintenance programs:
  – to insure chemical accident prevention,
  – protection of workers and
  – public safety
Risk management in Japan

• Law applies for new construction
• Older facilities not protected
• No written reports of process safety actions or other risk management information is required
• Reporting of chemical releases, no recording of natechs
Risk management in Japan

• No natech specific laws
• Natech risk reduction may be addressed indirectly through:
  – the adoption of strict seismic design codes
  – land use planning ordinances
  – construction of preventive infrastructure
• Past earthquakes have prompted adoption of earthquake hazard reduction measures
## Country Practices: Summary table

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Laws related to chemical accident prevention</td>
</tr>
<tr>
<td>United States, Federal level</td>
<td>Process Safety Management of Highly Hazardous Substances Risk Management Program (RMP)</td>
</tr>
<tr>
<td>California</td>
<td>Accidental Release Prevention Program (CalARP) which specifically requires industrial plants to carry out a seismic. No, provisions for domino effects or land use planning</td>
</tr>
</tbody>
</table>
## Summary of actions that directly or indirectly address natech risk at the EC level, and in individual countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Community level</td>
<td>Articles 6 and 8 address prevention, preparedness and response. Requires analysis of external hazards (e.g., seismic risk or floods). Little guidance on specific actions to be taken. Only governs sites housing certain chemicals, others with non-Seveso II chemicals may not be protected.</td>
</tr>
<tr>
<td>Italy</td>
<td>Seveso II Directive, same as above</td>
</tr>
</tbody>
</table>
Are we at risk of natech disasters?

Interdependent and complex urban systems

More people, More infrastructure, More hazards
Conclusions:

• Little systematized information on actual risk of natechs
  – Little recording of natech incidents
  – Little or no valuation of monetary losses or costs
• Few studies on what governments and communities are doing to prevent and prepare for natechs
• Little guidance available on how to prepare
• Natech risk management requires that experts, government officials, emergency managers and the public work together
Research Needs:

• Systematic data on natech incidents is needed (most countries already collect data on chemical accidents)
• More detailed studies on natech risk management at regional and city level
• Collection of data on social-economic losses due to natechs would serve to quantify the problem
• Development of simple, easy to use natech hazard and vulnerability assessment methods
Recommendations:

Natech risk reduction should include:

- emergency planning and risk management for natechs,
- education of public and policy makers,
- public participation in natech risk reduction and
- land use planning and risk mapping of natechs
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