



European  
Commission

# Natech risk assessment and management

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in-house science service

Joint  
Research  
Centre



Flood, 2007



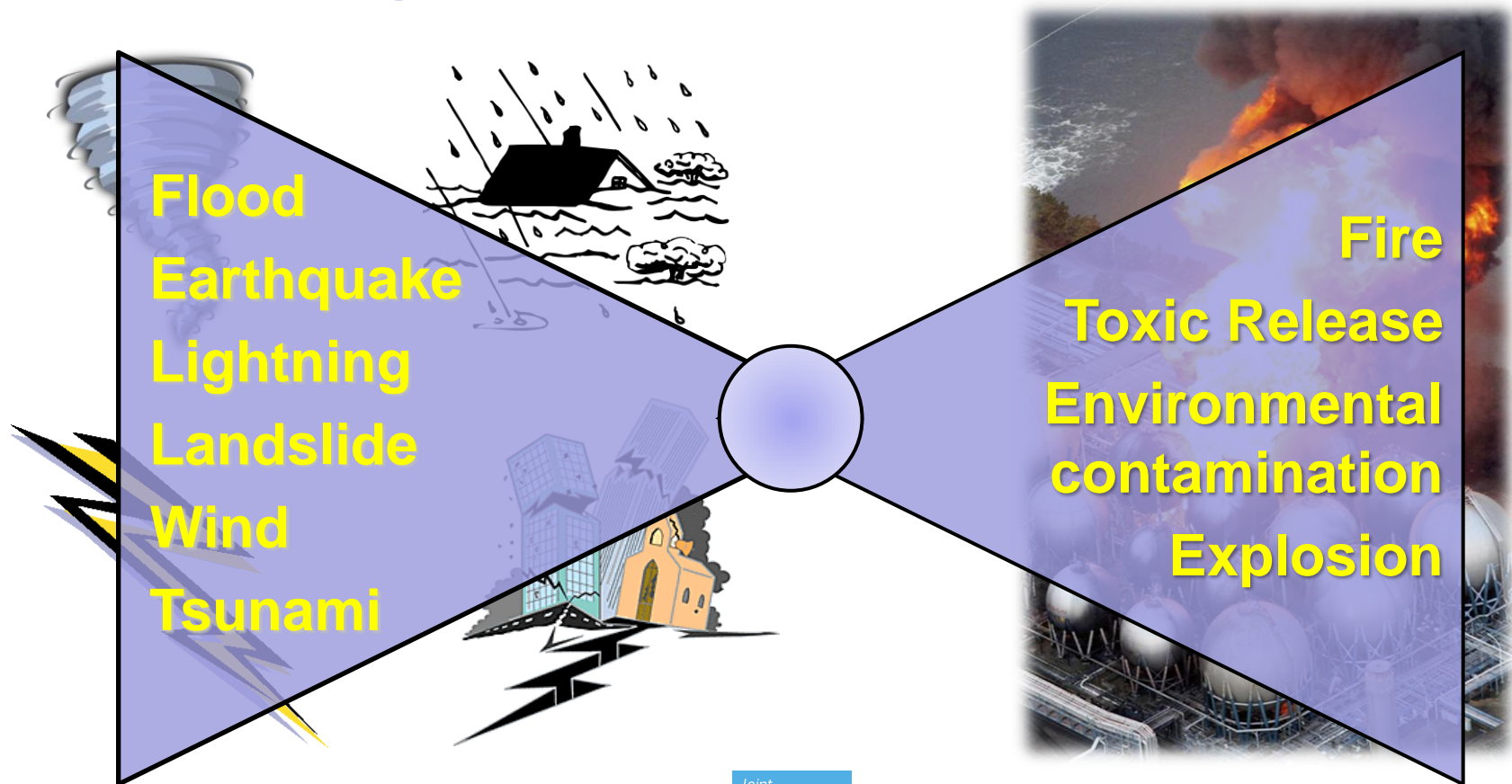
Earthquake, 2011



Hurricane, 2005



# Natural hazard triggered technological accidents





**At least 40% of surveyed EU MS and OECD Member Countries have experienced one or more Natech accidents**

## ***Hurricane Sandy (USA, 2012)***

*→ multiple hydrocarbon spills (>1.3 million lt); 42 billion lt of sewage spilled*

## ***Tohoku earthquake and tsunami (Japan, 2011)***

*→ major nuclear accident; fires and explosions in refineries, petrochemical and other facilities*

## ***Hurricanes Katrina/Rita (USA, 2005)***

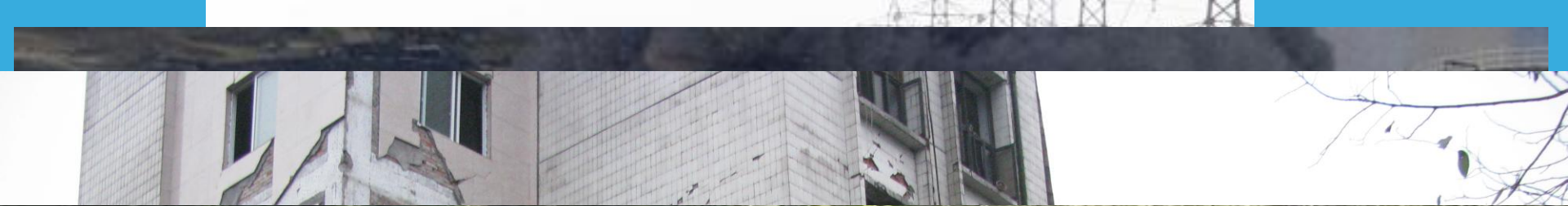
*→ 113 off-shore platforms destroyed, 163 severely damaged; release of 30 million lt oil on- and offshore; hike in global oil price*

## ***Summer floods (Czech Republic, 2002)***

*→ release of 80 t of chlorine & several dozen tons of other hazardous chemicals, including dioxins*

## ***Kocaeli earthquake (Turkey, 1999)***

*→ multiple fires in a refinery producing 1/3 of Turkey's oil-related output*



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## Natech risk-reduction situation

- Legislation, codes and standards for chemical-accident prevention rarely address Natech risk explicitly (*BUT: Seveso III, regional acts!*).
- There is little knowledge on the dynamics of Natech accidents.
- There are hardly any methodologies and tools for Natech risk assessment and no guidance for industry on how to assess Natech risk.
- Emergency response plans do not consider the characteristics of Natech accidents (loss of utilities).
- There are no Natech risk maps to identify areas in danger.

## Expected increase in Natech risk:

→ **more hazards**

(climate change, industrialisation)

→ **higher vulnerability**

(urbanisation, interconnectedness)

**... in a situation where Natech risk assessment methodologies & tools and guidelines for Natech risk management are missing.**

*\*From a JRC survey on the status of Natech risk reduction in EU MS and OECD*

*E. Krausmann, D. Baranzini (2012) Natech risk reduction in the European Union, J Risk Research 15(8): 1027-1047*

## Priority work areas\*:

- Implement and enforce regulations for Natech risk reduction
- Develop methods, tools and guidance for Natech risk management
- Develop dedicated Natech emergency management plans
- Develop Natech risk maps
- Raise awareness and improve risk communication
- Train stakeholders on Natech risk reduction

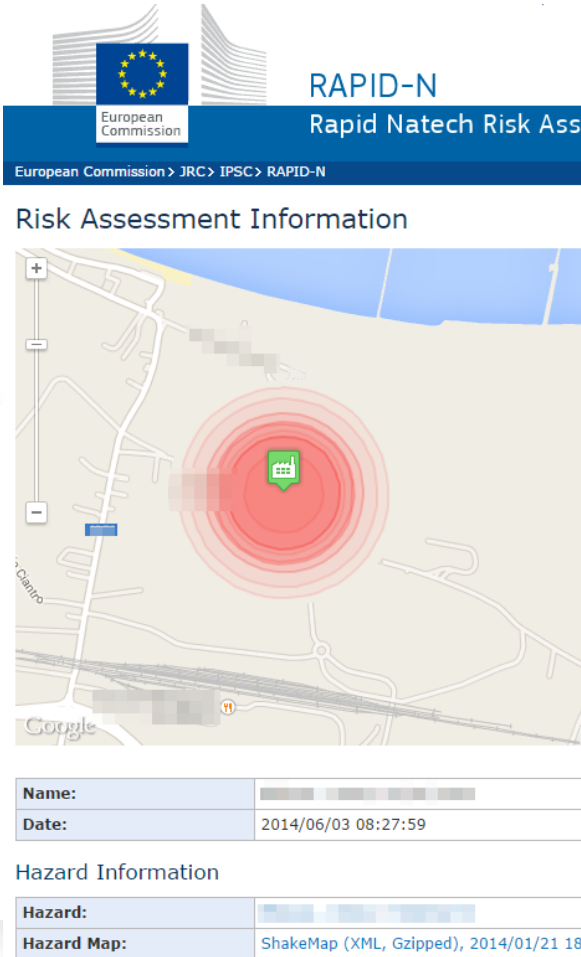
## Accident analysis and guidance

- Identification of vulnerable equipment (*fixed, pipelines, offshore*), scenarios and consequences (*earthquakes, floods, lightning, hurricanes*)
- Site surveys for Natech damage assessment (*Japan, China*) & statistical analysis, lessons learning
- Natech accident database: **eNatech**  
<http://enatech.jrc.ec.europa.eu>

## Risk analysis tools

- Framework for Natech risk assessment and mapping: **RAPID-N**  
<http://rapidn.jrc.ec.europa.eu>

## Training



**RAPID-N**  
Rapid Natech Risk Assessment

European Commission > JRC > IPSC > RAPID-N

Risk Assessment Information

Name: [redacted]  
Date: 2014/06/03 08:27:59

Hazard Information

Hazard: [redacted]  
Hazard Map: ShakeMap (XML, Gzipped), 2014/01/21 18:00:00



## Lessons-learning process:

- **Accident investigation**
  - why and how did the accident happen?
- **Accident reporting**
  - minimum of information according to a pre-defined set of criteria (incl. near misses)
- **Data collection**
  - relevant and structured information on accident and safety measures
- **Data analysis**
  - detect accident causation patterns (should include mitigation)
- **Generation of lessons learned and implementation**
  - technical/organisational LL



# JOINT RESEARCH CENTRE

## eNATECH - Natural hazard-triggered technological accidents

European Commission > JRC > IPSC > eNatech

### Natechs

Country:  Hazard:  Natech ID:

Site:  Date:  -  Status:

50 record(s) found. Page:  Rows:  Sort by:

No	Date	Country	Natural Hazard	Site	Natech ID
1.	1923	Japan	Tokyo Earthquake	Yokosuka Naval Base	10

<http://enatech.jrc.ec.europa.eu>

					Authority	
5.	1989/09/20	United States	Hurricane Hugo	Amerada Hess Oil Co.	55	!
6.	1994/01/17	United States	Northridge Earthquake	ARCO-Four Corners Pipeline	44	!
7.	1994/02/22	South Africa	Merriespruit rain	Harmony Gold Mine	56	!
8.	1994/07/24	United Kingdom	Lightning	Pembroke Refinery	47	!
9.	1994/10/19	United States	San Jacinto River Flood	Pipeline	45	!
10.	1995/10/24	Indonesia	Lightning	Pertamina Cilacap Refinery (Unit Pengolahan IV)	4	!
11.	1998/02/27	Ecuador	Landslide	Trans-Ecuadorian Oil Pipeline	38	!
12.	1998/04/25	Spain	Doñana Disaster/The Los Frailes tailings dam failure/Aznalcollar Disaster/Guadiamar Disaster	Los Frailes mine	27	!
13.	1998/09/26	United States	Hurricane Georges	Chevron Pascagoula Refinery	3	!
14.	1999/08/17	Turkey	Kocaeli Earthquake	TUPRAS İzmit Refinery	2	!
15.	1999/08/17	Turkey	Kocaeli Earthquake	AKSA Acrylic Fiber Production Plant	5	!
16.	2000/01/30	Romania	Heavy rainfall	Aurul Mine	28	!









**Where are natural-hazard prone areas and which chemical facilities are at risk there?**

**RAPID-N: Web-based decision-support tool for Natech risk assessment and mapping**

**RAPID-N unites natural-hazard assessment, damage estimation, and consequence assessment in one tool!**





RAPID-N

Rapid Natech Risk Assessment Tool

European Commission > JRC > IPSC > RAPID-N



<http://rapidn.jrc.ec.europa.eu>



## Recent Natural Hazards

	Date	Name
	2015/03/05	255km SSE of Sinabang, Indonesia
	2015/03/03	50km NW of Sikabalan, Indonesia

## RAPID-N: Rapid Natech Risk Assessment Tool

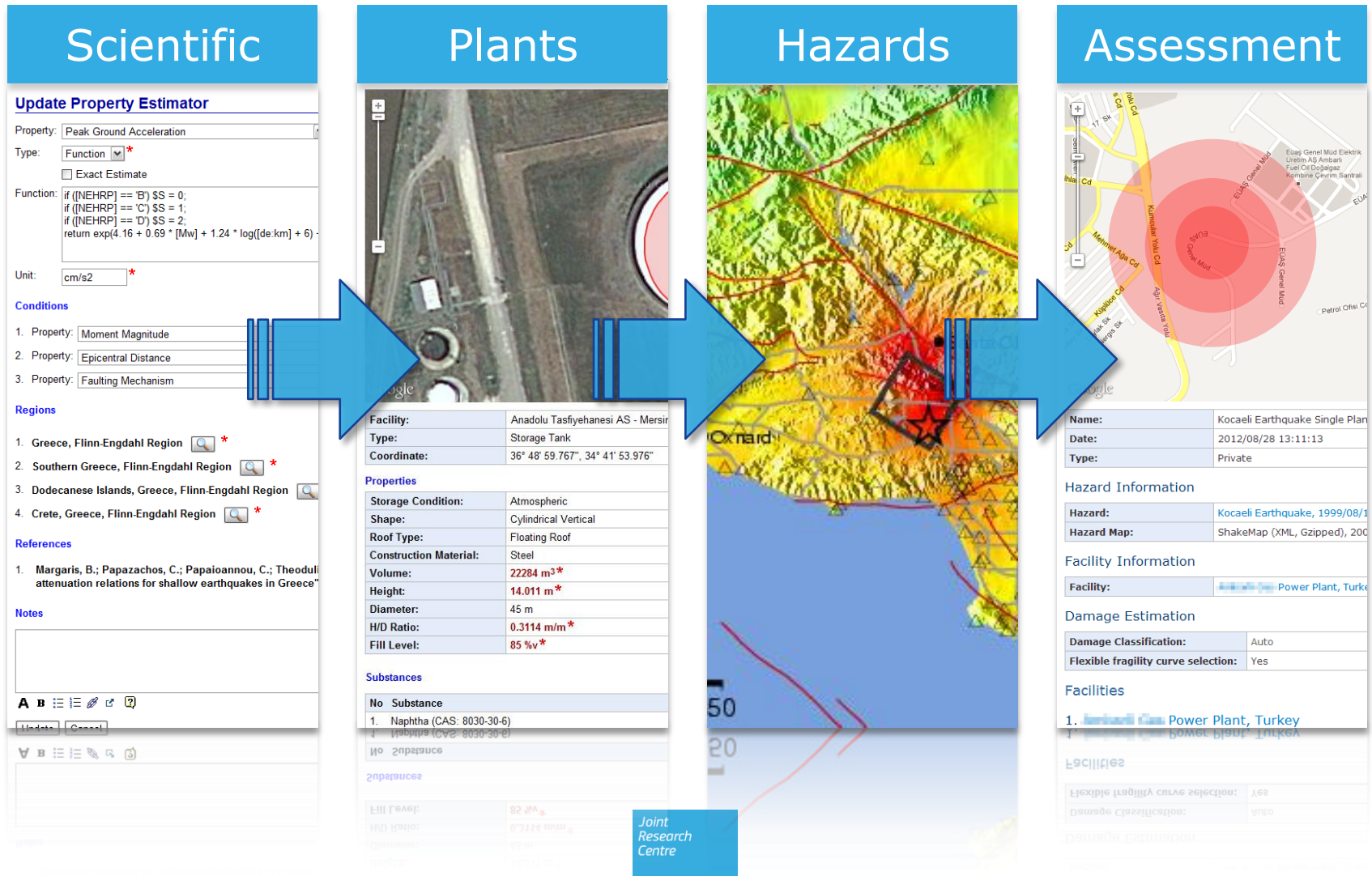
Natural-hazard triggered technological accidents (Natechs) involving the releases of hazardous







## Modular Structure



# Risk Assessment

## Create Risk Assessment

Name: Near the East Cost of Honshu, Japan, 2012/01/28

### Hazard Information

Hazard: Near the East Coast of Honshu, Japan, 2012/01/28

Hazard Map: ShakeMap (XML, Gzipped), 2012/01/28 00:42:19

### Industrial Plant Information

Industrial Plant: Plants within the cutoff distance

Cutoff Distance: 200 km

☐ Exclude plants without units

### Risk Assessment

Damage Classification: - Auto -

☒ Flexible fragility curve selection

☐ Use private property estimators

### Risk Assessment Parameters

1. Parameter: Ambient Temperature Value: 20 Unit: °C

2. Parameter: Topography Value: Urban

3. Parameter: RMP Scenario Value: Worst-case

### Notes

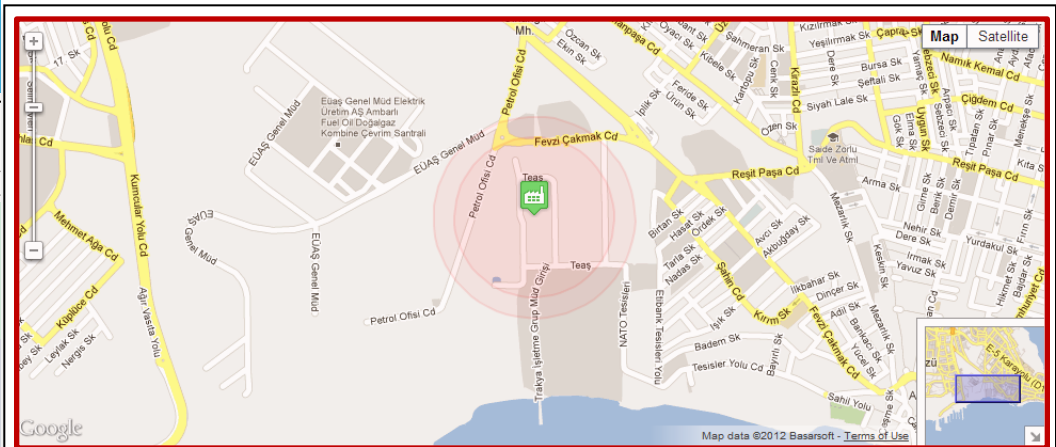
Automated natech risk assessment for Near the East Cost of Honshu, Japan Earthquake occurred on 2012/01/28.

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### Data Protection

Access: Private

Create Cancel



Name: Kocaeli Earthquake Single Plant  
Date: 2012/08/28 13:11:13  
Type: Private

### Hazard Information

Hazard: Kocaeli Earthquake, 1999/08/17  
Hazard Map: ShakeMap (XML, Gzipped), 2008/11/09 03:19:14

### Facility Information

Facility: Power Plant, Turkey

### Damage Estimation

Damage Classification: Auto  
Flexible fragility curve selection: Yes

### Facilities

#### 1. Power Plant, Turkey

No	Process Unit	Hazard Parameters	Fragility Curve	Damage Estimate	Damage Parameters	End-point Distance
1.	Storage Tank (T-STR) [Gasoline]	PGA: 18.777 %g; EMS: Slightly damaging; MM: Strong; MSK: Strong; MMI: 6.4866; d <sub>e</sub> : 101.38 km; d <sub>h</sub> : 102.79 km; PGA <sub>h</sub> : 74.415 cm/s <sup>2</sup> ; PGV: 15.573 cm/s	OS00-F50-G	≥ DS2: 4.0546%	Fire/Explosion Event: Vapor Cloud Explosion; Q <sub>involved</sub> : 4250 kg; f <sub>m</sub> , passive: 1; P <sub>c</sub> , fire: 100%; f <sub>v</sub> , involved: 10 %; V <sub>involved</sub> : 5.7432 m <sup>3</sup> ; P <sub>c</sub> , release: 30%; f <sub>yield</sub> : 0.1; RMP Scenario: Worst-case; t <sub>release</sub> : 10 min; Q <sub>release</sub> : 425 kg/min; Q <sub>released</sub> : 4250 kg; A <sub>pool</sub> : 6146.1 ft <sup>2</sup> ; h <sub>pool</sub> : 1 cm; Q <sub>release</sub> , r: 425 kg/min; T <sub>a</sub> : 1; R: 0.4; q <sub>r</sub> : 5000 W/m <sup>2</sup> ; t <sub>exp</sub> : 40 s; D <sub>T</sub> : 342 TDU; d <sub>e</sub> : 270.58 m; Q <sub>fuel</sub> : 4250 kg; P <sub>damage</sub> : 4.0546%; P <sub>natech</sub> : 4.0546% <<	271 m: 4.0546%
				≥ DS3: 0.004631%	Fire/Explosion Event: Vapor Cloud Explosion; Q <sub>involved</sub> : 8500 kg >>	341 m: 0.004631%
				≥ DS4: Very low	-	-

## Natural Hazard

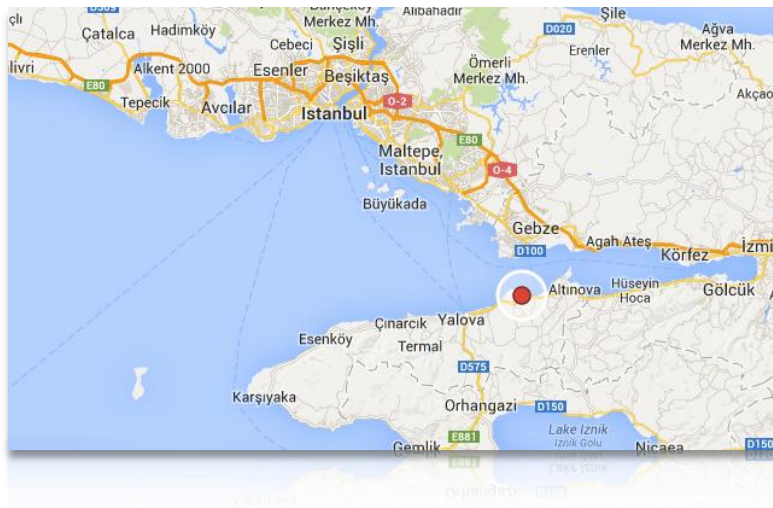
- Istanbul Earthquake
- Scenario
  - **JICA (2002) Model A**
- Epicenter
  - **40° 45.00'N 29° 24.00'E**
  - **Focal depth 10 km**
- Fault
  - **Fault length 154 km**
  - **Strike-slip**
- Magnitude
  - **Mw 7.5**





## Industrial Plant

- Located in Izmit Bay
- Fiber production
- 315,000 ton/year capacity



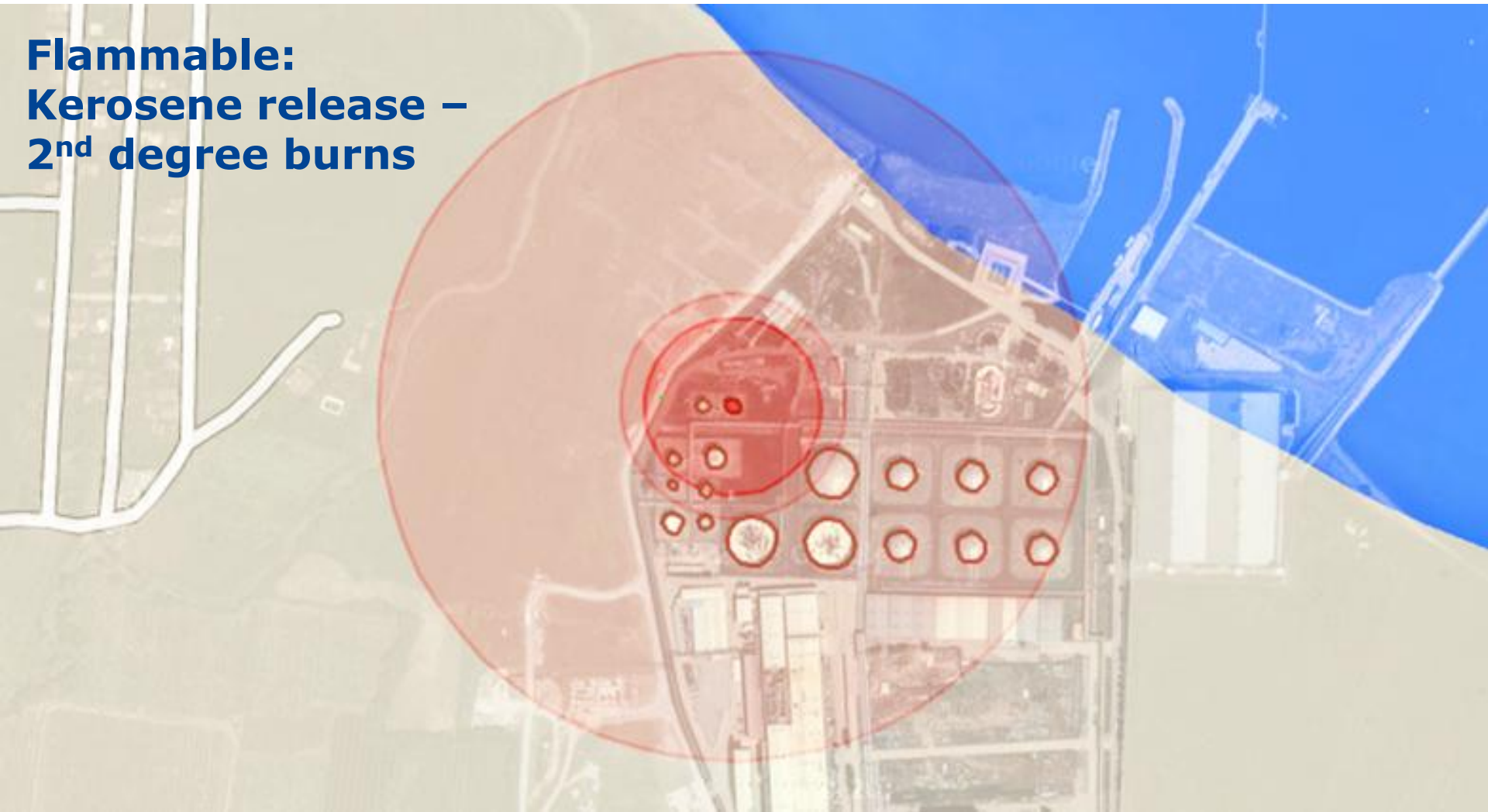


**Kerosene**

**Acrylonitrile**



**Flammable:  
Kerosene release –  
2<sup>nd</sup> degree burns**





# Toxic: Acrylonitrile release – ERPG-2



# RAPID-N: Ongoing and future research

- **Extension to other natural hazards and infrastructures**
  - Pipelines (ongoing), Floods (ongoing), Lightning (planned)
- **Automated Natech damage and consequence estimation (Alert)**
  - Reporting to interested parties and authorities
- **Cascading effects**
- **Consideration of risk receptors**

# TRAINING

**Assessing and reducing  
the risk of natural-hazard  
impacts on hazardous  
installations**

**March 2016:**

EU Enlargement and  
Integration Action countries

**February 2017:**

EU Member State  
authorities





1. The chemical industry is vulnerable to natural-hazard impact but this is not always recognized
2. The most vulnerable equipment type are atmospheric storage tanks with a high storage capacity and a high likelihood of release during natural hazards
3. The design basis of hazardous installations is not always adequate for natural-hazard loading and design limits need to be understood and acknowledged
4. Natech risk reduction measures are available for several natural hazards and research is ongoing to fill existing data and knowledge gaps

# Thank you for your attention!



RAPID-N tool for rapid Natech risk assessment and mapping:  
***[rapidn.jrc.ec.europa.eu](http://rapidn.jrc.ec.europa.eu)***



eNATECH database for Natech accidents  
***[enatech.jrc.ec.europa.eu](http://enatech.jrc.ec.europa.eu)***

**Contact: [elisabeth.krausmann@ec.europa.eu](mailto:elisabeth.krausmann@ec.europa.eu)**