Simone Vivarelli

Alma Mater Studiorum - University of Bologna

STRUCTURAL AND ENVIRONMENTAL HEALTH MONITORING AND MANAGEMENT
SEHM²

RISK ASSESSMENT AND MANAGEMENT OF MAJOR ACCIDENTS TRIGGERED BY EXTERNAL EVENTS

Advisor:

Prof. Ing. Valerio Cozzani

Co-Advisor:

Ing. Marco Buldrini

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Introduction - What are NaTech events?

Strong initiator event

External event

Danger aggravated due to the presence of

Hazardous material and dangerous operating condition

Danger for population and environment

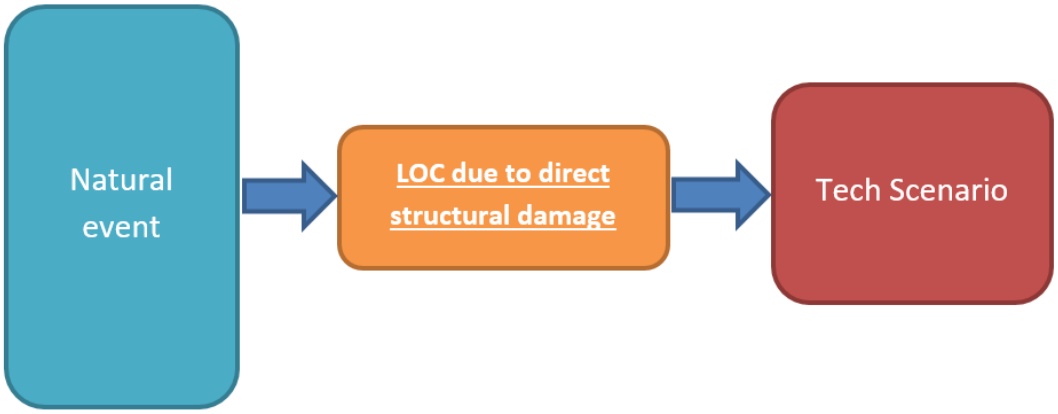
Accident (Na-Tech)

Recent studies has discovered that natural-related accident are both more frequent and more dangerous than conventional accidents.

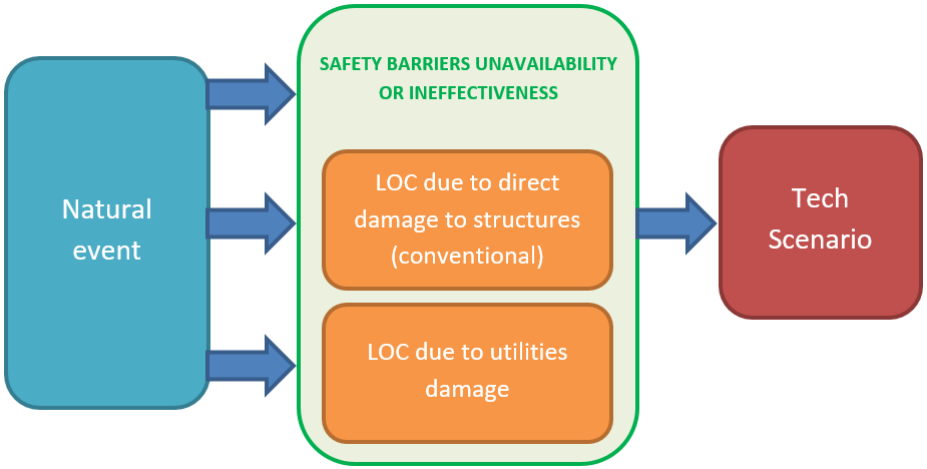
A few examples:

- Floods;
- Earthquakes;
- Lightning.

Utility-based approach to NaTech risk assessment



LOC: Loss of containment



1. **Conventional approach:** a natural event produces a structural damage to equipment units

2. **Specific utilities approach:** a natural event damages the utility system, producing a different kind of loss of containment

Identification of those classes of substances that require an utility system

Group ID	H statements		Seveso category	Reference scenario
Heat sensitive substances	Heat sensitive	H251 H252	None	Fire
	It can explode or burn in case of heating	H229 H240 H241 H242 EUH044	P6a, P6b	Explosion/Fire
Water reacting substances	In contact with water it produces flammable gases (even self-ignitable)	H260 H261	O2	Flash fire
	It reacts strongly in contact with water	EUH014	O1	Toxic dispersion/Fire
	If in contact with water/acids, it yields toxic gases	EUH029 EUH031 EUH032	O3	Toxic dispersion
Air reacting substances	Spontaneously flammable in contact with air	H250	P7	Fire

Particular substances that need an utility: Self heating substances, self reactive substances, in contact with air/water produces flammable gas

Validation of category choice through its application to a brief case study

Air, heat and water sensitive substances inventory within Seveso-III subjected facilities

ID	Hazard category	Substances (examples)	H Statement	Upper tie (t)	Lower tie (t)	Declared inventory
plant_D	P6b	2,5-Bis(tert-butylperoxy)-2,5-dimethylhexane	H242	50	200	11
	P7	Aluminium alkyls	H250	50	200	50
	O1	Catalyst	EUH014	100	500	1300
	O2	Aluminium alkyls	H260	100	500	50
plant_L	P6b	Peracetic acid	H242	50	200	65
plant_M	P6b	Paramentan hydroperoxide	H242	50	200	30
	P7	n-Butyllithium	H250	50	200	163
		Diethylaluminum chloride				
		Diisobutylaluminum chloride				
		Ethylaluminium sesquichloride				
		Diisobutylaluminium hydride				
	O1	n-Butyllithium	EUH014	100	500	204
		Chlorosilane				
		Diethylaluminum chloride				
		Diisobutylaluminum chloride				
		Ethylaluminium sesquichloride				
		Diisobutylaluminium hydride				
		Magnesium alkyls				
	O2	n-Butyllithium	H260	100	500	177
		Diethylaluminum chloride				
		Diisobutylaluminum chloride				
		Ethylaluminium sesquichloride				
		Diisobutylaluminium hydride				
		Magnesium alkyls				
plant_N	P6b	Benzoyl peroxide	H242	50	200	5
		tert-Butyl hydroperoxide				

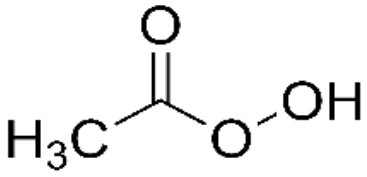
The proposed approach was confirmed by a so called “inventory analysis”, conducted on a set of 22 existing industrial facilities, consisted in a statistical research of the above-mentioned susceptible substances.

The analysis yielded a positive and encouraging outcome of 18% presence

Case study based on representative substances

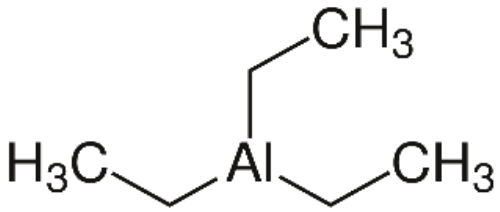
1. **Heat sensitive substances:** peracetic acid

It produces oxygen in case of heating, so the consequence could be an explosion in case of loss of cooling system (referred to either a single cooled storage or a warehouse). It could aggravate a fire, since it is an oxidizer.



2. **Air sensitive substances:** triethylaluminium (aluminium alkyls)

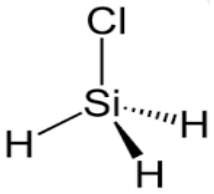
It strongly and exothermically react in contact with air



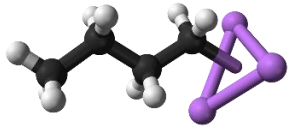
Case study based on representative substances

3. **Water sensitive substances:**

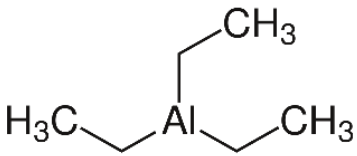
- chloro-silane: in contact with water it produces hydrogen chloride (HCl), which is a toxic and corrosive gas.



- n-butyllithium: in contact with water it produces lithium hydroxide (LiOH), which is a corrosive substance.

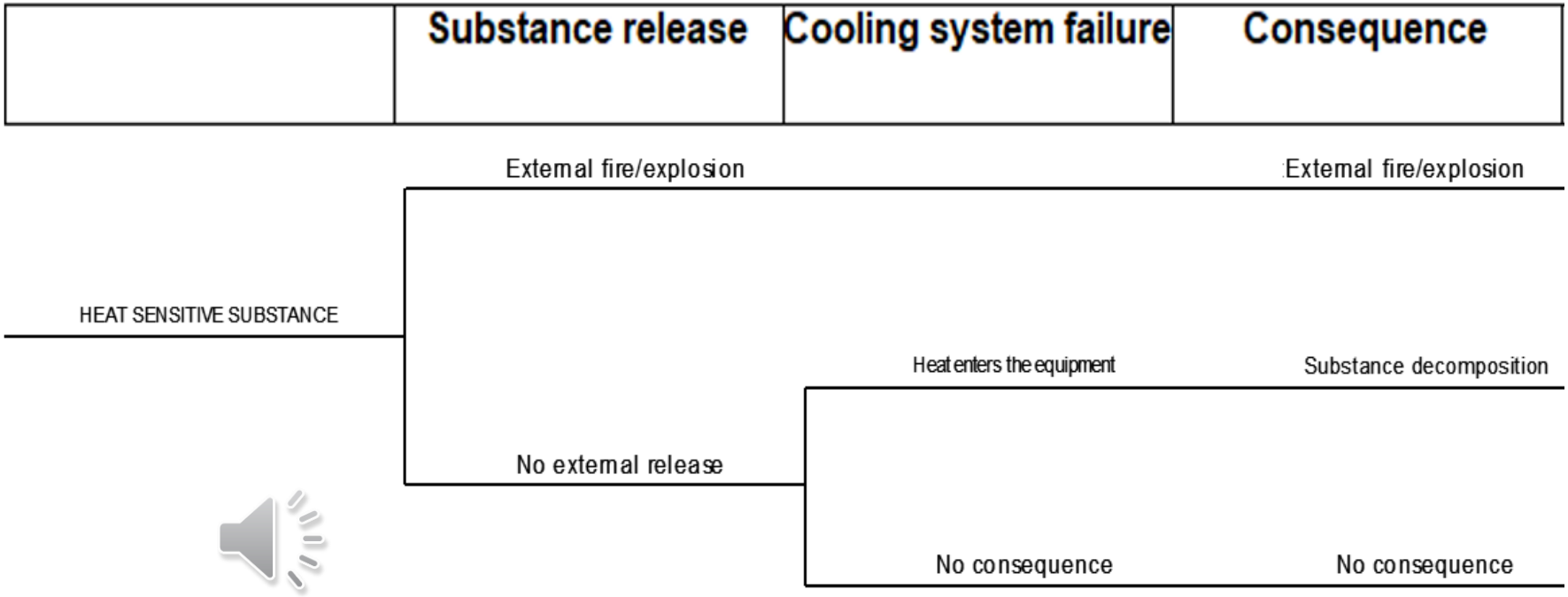


- triethylaluminium (aluminium alkyls in general): in contact with water it produces ethane, which is an extremely flammable gas.



Integrated approach to NaTech risk assessment – Specific event tree

1. Particular substances that need an utility (example of an event tree), for example heat sensitive substances.



2. NaTech-specific event tree

2. Specific event tree in the case of FLOOD: a checklist is set in order to detect the adequacy of utility system against floods.

The type of utility involved in the analysis are:

1. **NITROGEN BLANKETING SYSTEM**
2. **ELECTRICITY SUPPLY**
3. **REFRIGERATING SYSTEM – SUB ZERO SERVICE**
4. **REFRIGERATING SYSTEM – OVER ZERO SERVICE – COOLING WATER**
5. **FIREFIGHTING SYSTEMS**
6. **CATCHING BASINS**
7. **SEWER SYSTEMS**

2. NaTech-specific event tree

Example of a check-list:

I.E. NITROGEN BLANKETING SYSTEM

- Nitrogen blanketing system: is it existing?
- Where nitrogen is stored? In which physical phase? (gaseous, refrigerated liquid, etc.)
- How long its availability is guaranteed? (i.e. in case of provision impossibility)
- Does a backup storage exist?
- What equipment are interposed between the storage and the consumers? (in particular, critical consumers with respect to nitrogen)
- Which nitrogen deficiency detection systems are present? How do they work? Are they manual or automatic?
- What are credible failures in the case of flood?

Further activities

- Applicate to a real case study the event tree performed for the specific sensitive substances.
- Evaluate the adequacy of utility systems and safety barriers commonly implemented in industrial sites, especially in the case of flood.
- Verification of the available quantitative damage models for equipment, and eventually developing of new models in order to describe the physical behaviour of interest in the case of flood.