Reaction in Waste Container - Leading to Major Evacuation

Vihtavuori, Finland July 2013

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July 9th 2013

- At midnight – the guard notices steam from one IBC, calls duty officer – rescue services alerted
- Thus far - a problem, not a disaster
- During the night, temperature measurements from a distance and observations with a drone
- In the morning hours – worst case calculation based on

  - all containers full of sensitized emulsion

  - AND all detonate at once

  - AND TNTeq = 1

  - AND ANFO stored in the adjacent building detonate

  → decision to evacuate

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The Steaming Container

- Unsafe for rescue services to approach the area.
- Prolonged fire or detonation could spread the other containers and explosives inside the warehouse.
- Rescue operations viewpoint - essential to know the type and amount of chemicals and/or explosives inside a particular container - in this case it was unknown
- Rescue services decided to evacuate all people - first the factory area then the Vihtavuori village - before attempting to treat the container

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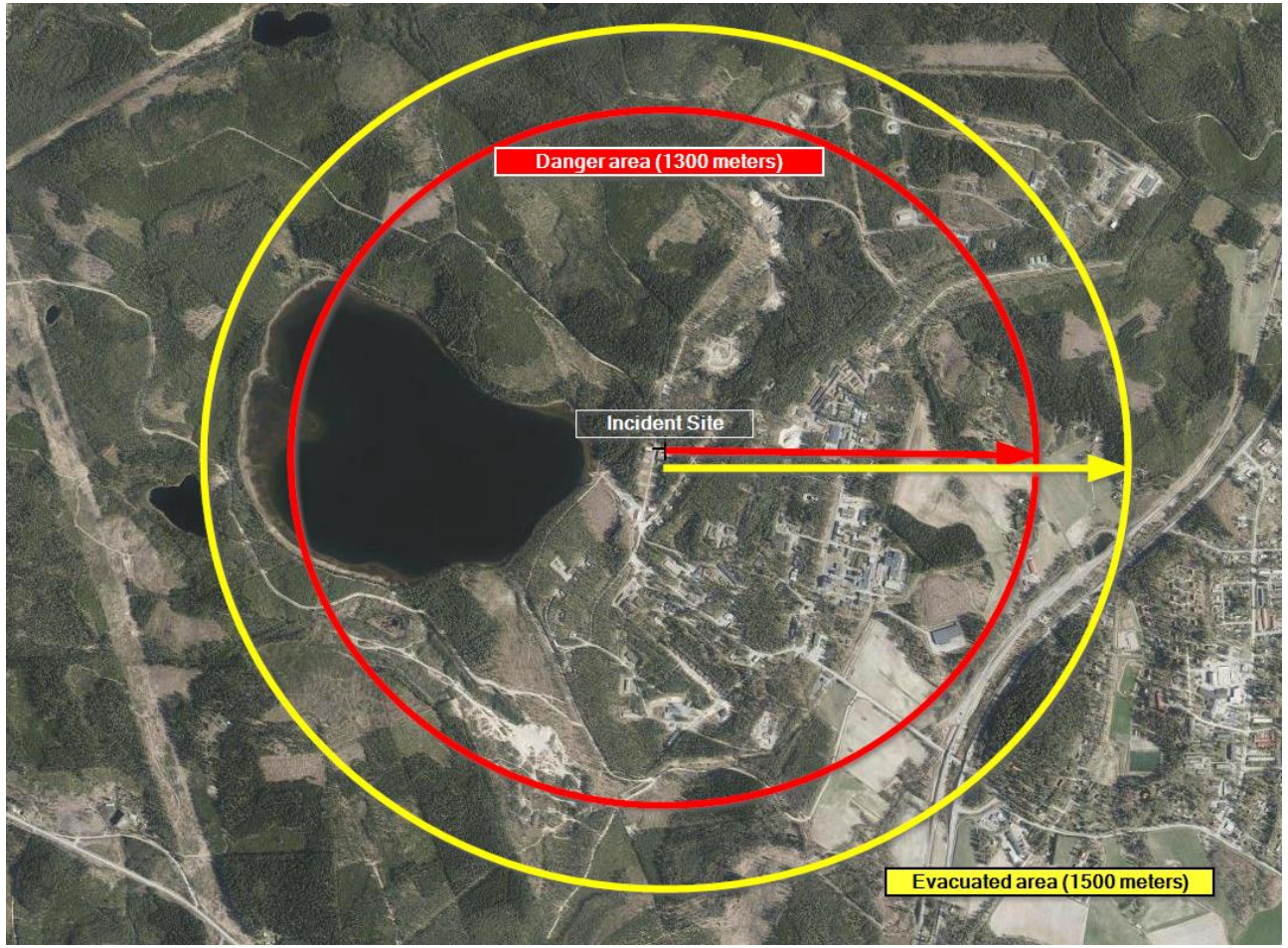
The probability of a detonation was low – but not zero

- We were unsure on many risk variables, hence the worst case scenario
- TNTeq – is not 1, but we did not really know. In hindsight non-ideal detonation, low TNTeq
- Water would reduce risk and mitigate an explosion – no information of water content at the time
- How would the adjacent containers react
- We clearly lacked essential information

The evacuation



- At the time of the event, it was estimated that the direct effect of an explosion and its consequences could extend to a radius of about 1300 metres from the explosives warehouse.
- Domino effect was the key consideration– neighbouring company had large volumes of nitric acid
- To safeguard all nearby inhabitants, the rescue services extended the evacuation zone to cover all 2200 residents of Vihtavuori Village.
- In practice, 450 people were evacuated; the rest left voluntarily, or were assumed to be away from home.

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Cooling

- The content generated heat. We knew that many containers had plenty of water – still a risk of a run-off process.
- As long as the steam was colourless – fine
- What happens when the steam becomes brown?
- First step was to spray water on top of the containers. Next step was to get water inside. Finnish Defence Forces used a Remotely Operated Vehicle to punch a hole in the container
- After getting water inside the container the situation was deemed safe – container could be moved, after all adjacent containers were moved first

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Cooling

- On the right – the container reached a high temperature.
- The reaction had resulted in a hole on the right-hand corner. The area around the valve also clearly damaged.

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Content of the container

The content of the IBC-container - sensitized emulsion, rock material (pyrite), two primers, filter bags and other impurities

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Reaction inside the container

- According to investigations, the container contained a mixture of sensitized emulsion explosives and some pyrite. The ammonium nitrate in the emulsion reacted with pyrite. Such a reaction is known to eventually lead to fast decomposition and possible explosion of ammonium nitrate
- The possibility of such a reaction had been recognized before
- Forcit had together with the customer investigated the possibility of such a reaction. However, no reaction occurred in laboratory tests

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Media frenzy

- Press conferences - 3 televised nationally
- Many press releases (external and internal)
- Interviews; TV, radio, newspapers
- Info to employees, board members, customers
- The media pressure was extreme
- It had been a slow news week

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Nothing happened (?)

- After the container was cooled and moved the situation was deemed safe and the evacuation was lifted
- The ”intense” phase of the incident lasted from the night of the 9th to the evening of the 10th – 20 hours
- The following day – the authorities started the investigation
  - Police – main responsibility – many were initially suspected for aggravated criminal acts (jail time)
  - Tukes (Chemical safety authority) and OTKES (Accident investigation authority) participated – Tukes was also a suspect
- Media frenzy subsided few days
- No detonation, no fire, no injuries, limited environmental impact
- Huge impact mentally, company reputation, monetary impact not yet known (at this stage)
- Production started in couple of days

How did the materials end up in the container?

- An attempt to charge upholes - with emulsion explosives with a new mobile explosive manufacturing unit (Memu) had failed.
- As a result, a significant amount of sensitized emulsion dropped onto the tunnel floor.

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How did the materials end up in the container?

- The mine conditions can be characterized as dark, humid and muddy
- The mine operators knew how important it was to clean all sensitized emulsion from the tunnel floor – risk for a health and an environmental hazard.
- The mixture was collected into a container
- According to existing instructions waste emulsion must be send to Forcit.

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The reaction – why did the content ”react”

- Container was transported from the mine to Vihtavuori one year prior
- Contained water, sensitized emulsion, couple of primers and some pyrite - extensive contamination
- Stored outdoors – during winter the content had frozen and during spring thawing occurred – weeks prior to the incident it had been exceptionally warm – varying storage temperature
- In the presence of pyrite AN starts to decompose – initially very slowly – exothermic reaction – acceleration – eventually water starts to evaporate – generation of steam – until water has been exhausted – vapours would turn brown

Root cause for the incident – reacting to change

- The emulsion sales increased continuously – management issue
- The recipe had been developed but launched before proper long term testing – management issue
  - Crystals in matrix and constant need to be cleaned from matrix tanks – quality issue, generation of waste
- Not enough capacity to handle waste emulsion (storage, destruction) – application for a new storage area was pending - took longer than expected – management issue

- Public prosecutor claimed during the trial “ you’ve done all the right things but unfortunately too late”

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Lessons learned

- Always minimize waste and store no longer than necessary
- Containers should be stored in groups of 2x2x2, easy to observe and move
- Regular temperature measurements, camera surveillance
- Check the container condition upon arrival and regular intervals
- In case of contamination – burn immediately
- Proper inventory of containers – follow up
- Get help – during the incident and after the incident
- Keep your site crisis plan updated and personnel well trained
- Have adequate processes for handling of explosives and emulsion waste

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Lessons learned – Media pressure

- Crisis plan is essential
- Crisis communication should be a part of your incident training
- Media representatives are trained professionals
- In major incidents the pressure can be overwhelming – have adequate separate resources (incident/media)
- Trained facilitator present during the press conferences
- You can’t control the media

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After all these years

- After 5 years of legal battle – two managers and the company were fined
- Internal processes for waste handling working well – no incidents since 2013
- Generation of waste has reduced remarkably
- Waste storage is always kept at minimum level
- Alternatives to burning
- Know the properties and risks – really well
- Problems may rise gradually, slowly, unnoticed

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Personal thoughts

- The right and obligation to say STOP
- How to identify those who can handle pressure during crisis
- All parties need to understand the risks involved – make sure they do
- Be the expert. Be active and participate, otherwise authorities will make the decisions
- The value of an incident
- The ”punishment” is best served by telling the story

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Thank you!

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