EPSC
THE PROCESS SAFETY NETWORK

GELEEN NAK2 EXPLOSION

7 NOVEMBER 1975

Jaco Nel
Senior Process Safety Assurance Engineer –Sabic Geleen
EPSC Aachen December 2025

IN MEMORY OF THOSE WHO PASSED AWAY ON THE 7 NOVEMBER 1975

Huub Custers
Hub Daniëls
Sef Gardeniers
Broer Kusters
Harrie Laumen
Chrit Meijers
Gerard Gommans
Jos Muijtjens
Theo Muurmans
Ben Peters
Frans Vergoossen
Jan Vergooszen
Felix Willems
Peter van der Zijl

EPSC

BACKGROUND TO THE INCIDENT – NAPHTHA CRACKER 2 (NAK2)

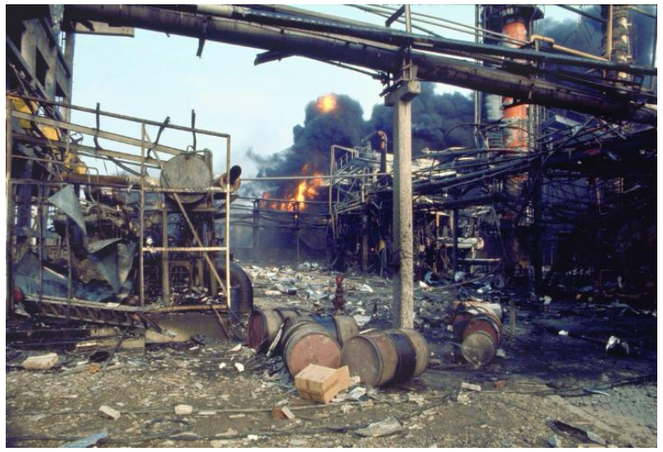
- Polythene became popular in the late 1950's and started to replace traditional materials such as metals, paper, glass in consumer products.
- Built in 1966 on the Geleen site in the Dutch Province of Limburg:

- NAK2 was constructed during a period of rapid growth in the polythene market – the capacity of the existing NAK1 cracker on the site was not enough to fully supply demand
- The 100 kTA Naphtha Cracker produced ethylene but also other base chemicals (propylene, butadiene, etc)

EPSC

BACKGROUND TO THE INCIDENT – PROCESS SAFETY IN THE 1970'S

1974- Flixborough
Explosion
28 fatalities



1975 – Geleen
Explosion
14 fatalities

1976 - Seveso
LOC of TCDD (dioxin)
640 injured civilians
80000 animal deaths

- It is evident that the 1970's were not particularly a good period in terms of process safety!
- Companies still had a very reactive safety culture.
- Process safety had not yet evolved as a discreet engineering field.
- HAZOP had only recently been conceived at ICI. Other tools such as QRA and LOPA did not even exist at the time.
- DOW F&EI had been published in the mid 1960's but by then these plants were already built.
- No Seveso directive, CCPS, EPSC, CSB, etc.

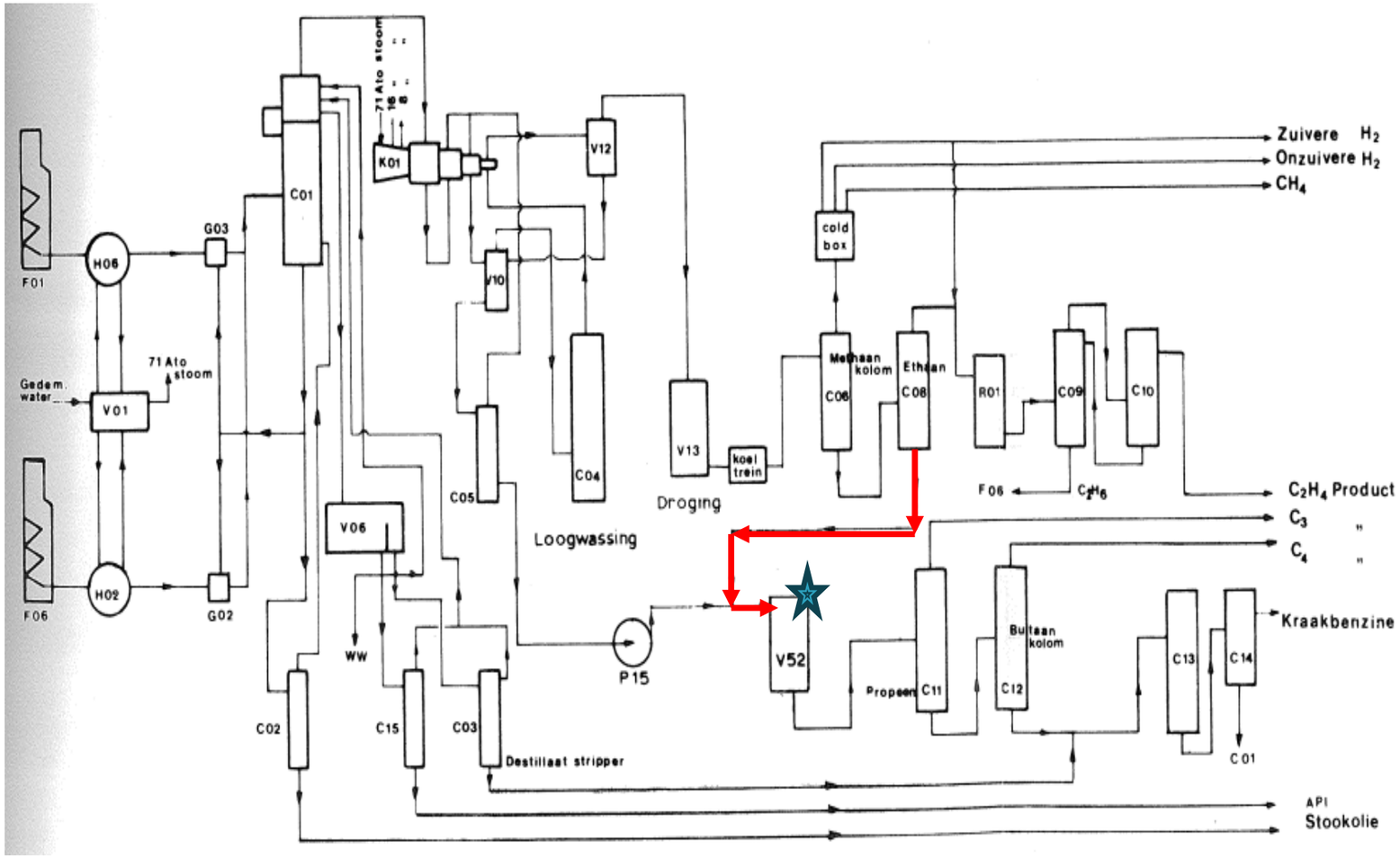
EPSC

OVERVIEW OF THE INCIDENT AT NAK2

- On the morning of 7 November 1975, the plant was in the process of starting up after a 2-month long outage called a turnaround to clean and inspect the equipment in the plant.
- At 09:45 a gas cloud was noticed in the center of the plant, and 6 minutes later a powerful explosion ripped through the installation.
- The explosion led to the death of 14 workers, all of whom were taking shelter in the control room or outside operator cabin in the plant.
- Additionally, a further 104 people suffered injuries on site and 3 offsite.
- More than 2000 homes in the vicinity suffered damage to windows but also to roofs
- A fire broke out in an adjacent tank farm and could only be extinguished by the 12th of November.
- The incident disrupted traffic throughout the province with a major highway next to the site being closed off for a protracted period.
- It ultimately required 200 firefighters, 21 fire trucks and 40 tons of firefighting foam to contain the situation.
- The plant was a total loss and was never rebuilt

EPSC

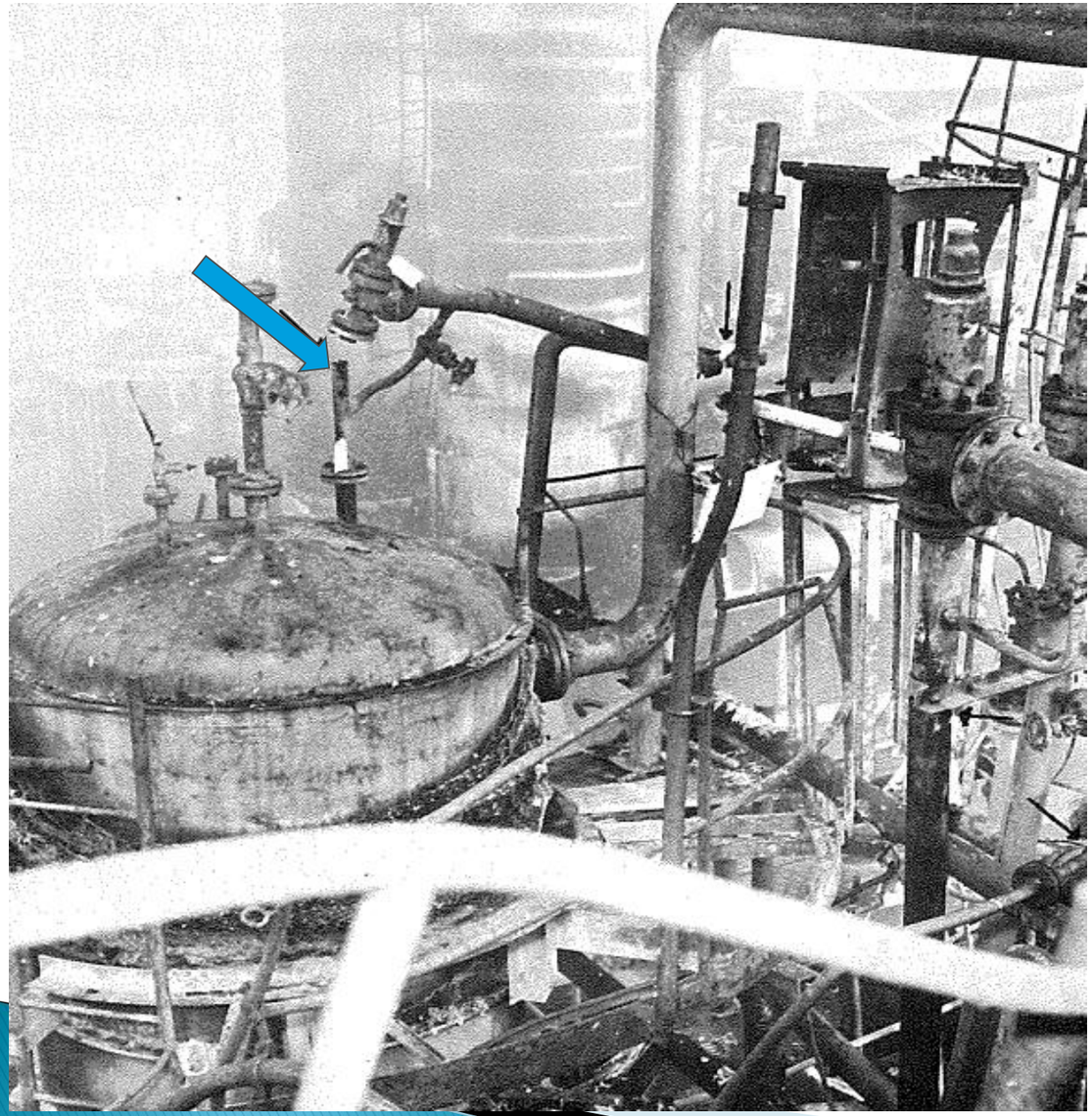
WHAT LED UP TO THE EXPLOSION

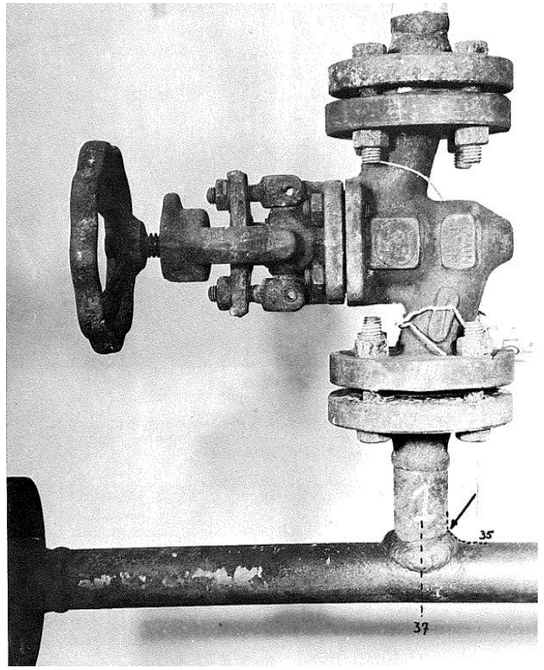


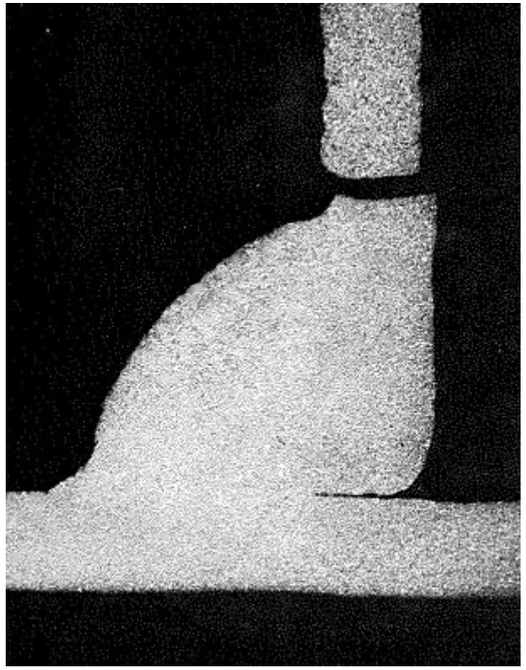
- During commissioning a refrigeration compressor tripped that also supplied heating to the de-ethanizer column reboiler
- Due to loss of heating, the bottoms temperature of the de-ethanizer column could not be maintained and much colder C2 fractions slipped through to the de-propanizer.
- The metallurgy of the de-propanizer section was not suited for these much colder temperatures and piping fractured due to cold embrittlement at weak points (weld seams).
- Most notably a safety valve on the V52 de-propanizer feed drum broke off and created a full-bore opening through which the C3/C4 fraction jetted out.

EPSC

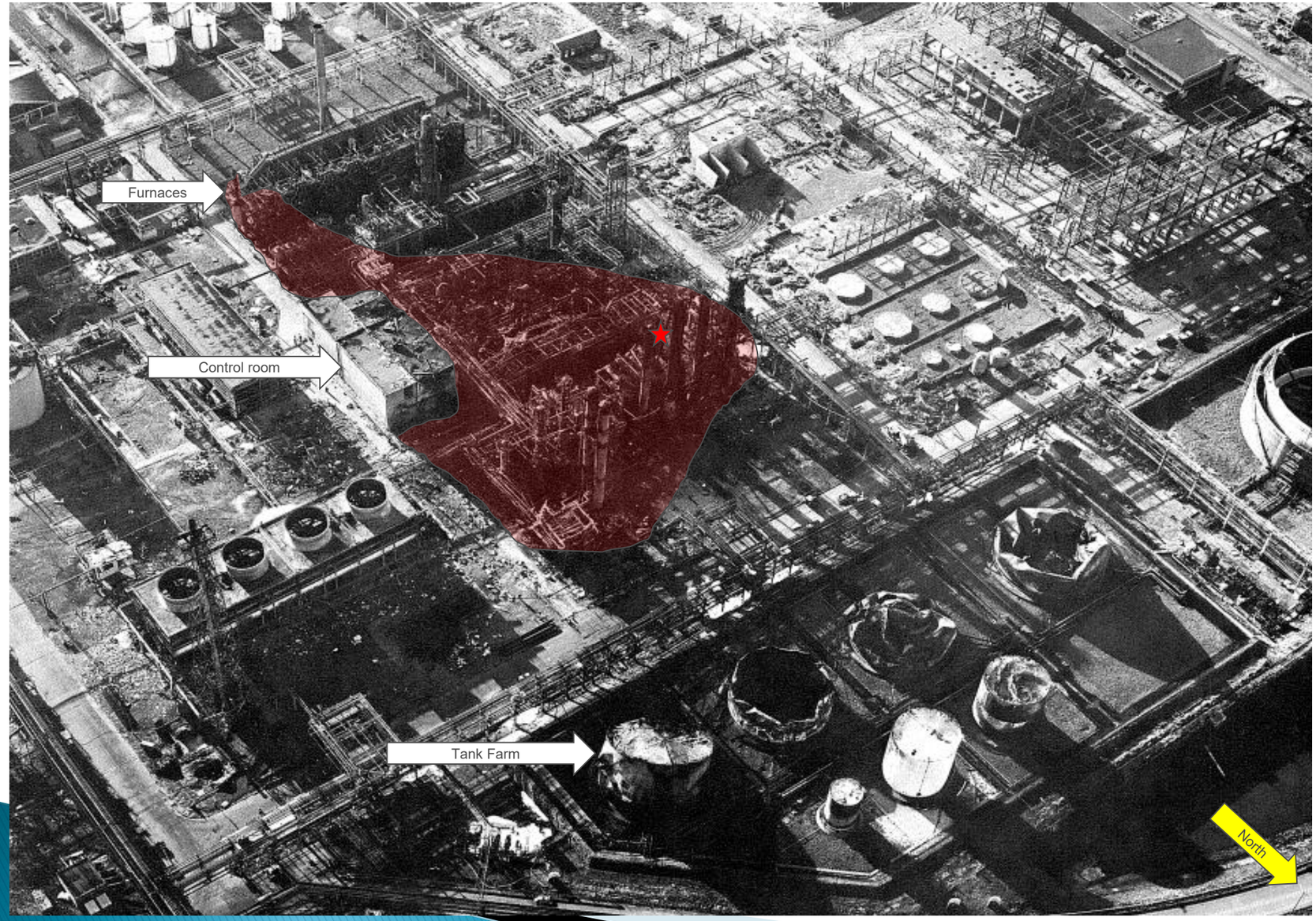
ROOT CAUSE – COLD EMBRITTLEMENT OF PIPING ON V52 DE-PROPANIZER FEED DRUM







LOC AND SUBSEQUENT GAS CLOUD DISPERSION



- Approximately 5.5 tons of gas leaked from the PSV on V52 for 6 minutes. The resultant gas cloud spread rapidly through the dense structure and was eventually ignited by a furnace on the other side of the plant
- It is evident from modelling that the initial deflagration transitioned to a violent explosion soon after ignition.
- The outside operator cabin– situated in the pipe rack close to the compressor house – was completely demolished and 8 operators lost their lives.
- The control room suffered severe blast damage, and 6 operators were fatally wounded inside.
- No evacuation alarm given prior to explosion – probably too much panic
- Blast ignited fires in the adjacent Tank Farm – firefighters battled several days to prevent a BLEVE occurring at the C3 sphere.

EPSC

MAJOR LESSONS LEARNT FROM NAK2

- **Cold Embrittlement** – direct cause of piping failure
- **Facility Siting/Spacing** – Congested plant contributed to severity of explosion, proximity of control room/cubicle to plant resulted in many fatalities
- **Emergency Response/Preparedness** – no alarm given, telephone lines overloaded.

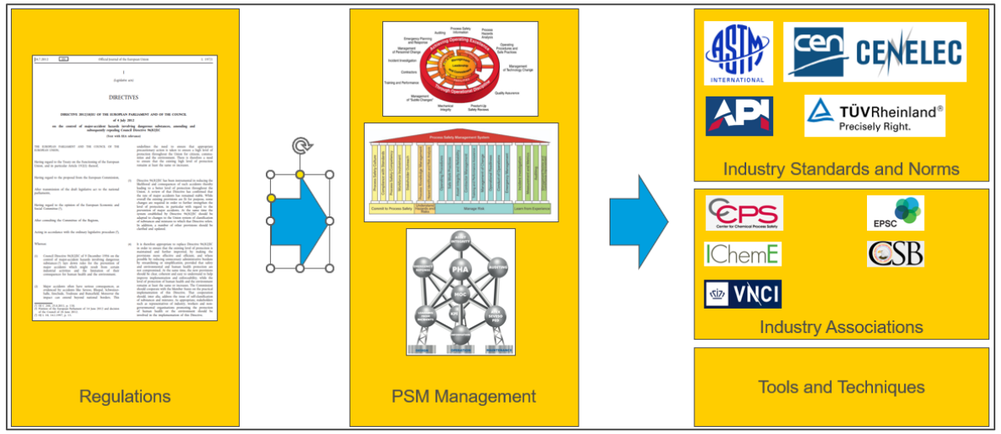
EPSC

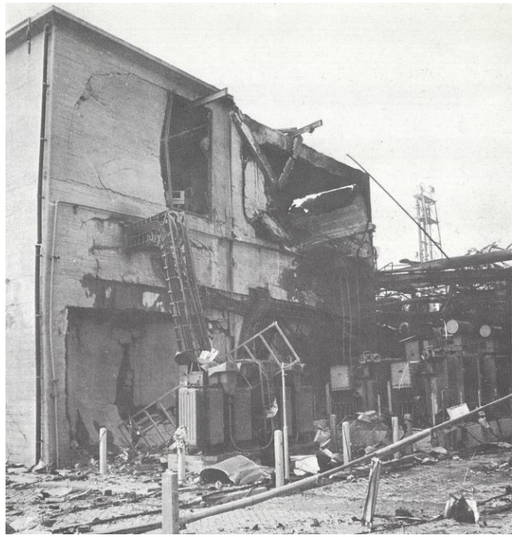
WHAT CHANGED IN THE INDUSTRY AFTER NAK2?

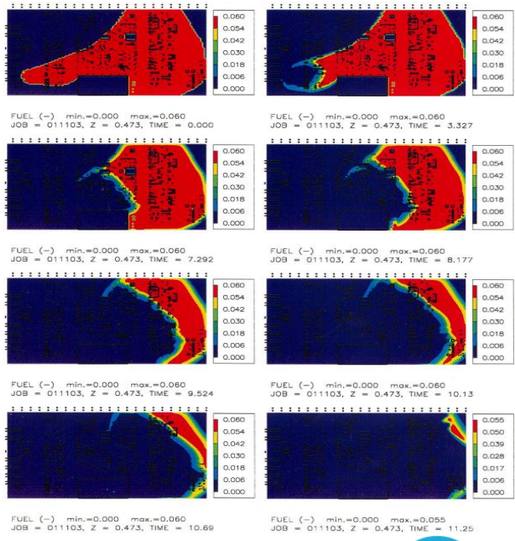
1. **Process Safety Management through better regulations/oversight, industry standards and tools**
   - SEVESO Directive came to exist specifically due to these 3 major incidents from 1974-1976
   - Various industry standards for process safety developed in the decades following these incidents
   - Tools such as HAZOP, LOPA, QRA assist us now in better classifying and safeguarding of potential hazards

2. **Improved Facility Siting/Lay-out Standards and Blast Modelling**
   - The traditional DOW F&EI has been supplemented with QRA modeling tools as well as industry standards such as API RP752 (Permanent Buildings) and API RP753 (Temporary buildings)
   - Information obtained from the violent NAK2 incident was used to develop and fine-tune future software modeling tools

3. **Much more knowledge on Cold Embrittlement and how to safeguard against it**
   - Low temperature safeguards on bottoms of de-ethanizer is now industry standard at steam crackers
   - General increased awareness of low temperature embrittlement at cryogenic, LNG and steam cracker plants.
   - Better selection and testing of materials of construction – EN ISO 148-1 (Charpy), EN ISO 15653, EN ISO 12135







ARE WE SAFE YET?

Since the 1970's, process safety has come along way to identify and manage risks.

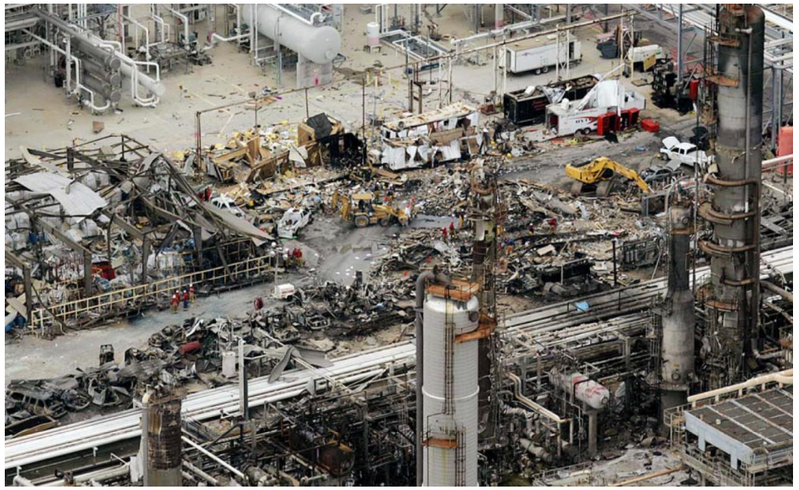
However, not all in the industry are quick to learn and adapt, and in the decades that followed, lessons learnt from the 1970's came back to haunt the industry.

1989 Phillips 66 explosion – Facility Siting

- Proximity of Control room to installation.
- 23 fatalities, ~US$2 Billion property loss.
- Lack of PHA, insufficient emergency measures contributed to disaster.

1998 ESSO Longford explosion – Cold Embrittlement

- No HAZOP, no proper MOC management, lacking leadership and safety culture.
- 2 fatalities, US$987 million property loss.



2005 BP Texas City– Emergency Preparedness

- Not only facility siting, but also emergency response found lacking.
- 15 fatalities, US$322 million property loss.

EPSC

KEY TAKE-AWAYS

- Regulations and industry standards **must be followed!** They have often been conceived after major calamities and loss of life and **protect** us from **repeating the mistakes** of the past.

- **Safety does in fact pay** – those who are slow to learn and adapt run the risk of learning this the hard way, as is evident in the preceding slides.

- **Industry has a very short memory** – hence it is of paramount importance to keep learning from past incidents, and implement the lessons learnt in PSM systems without wasting time to prevent it ever happening to you.

- **You are only as good as your last mistake** – stay humble and cautious, take the necessary care and make the best effort as an organization to prevent incidents.

EPSC

THANK YOU–AND PLEASE STAY SAFE

EPSC