



30 years on from Bhopal

**ECCE-10,
29th Sep 2015, Nice, France**

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30 years on from Bhopal

1. What happened?
2. The situation in Bhopal today
3. Call for action – what needs to be done?



Bhopal - what happened? ...the gas release and consequences

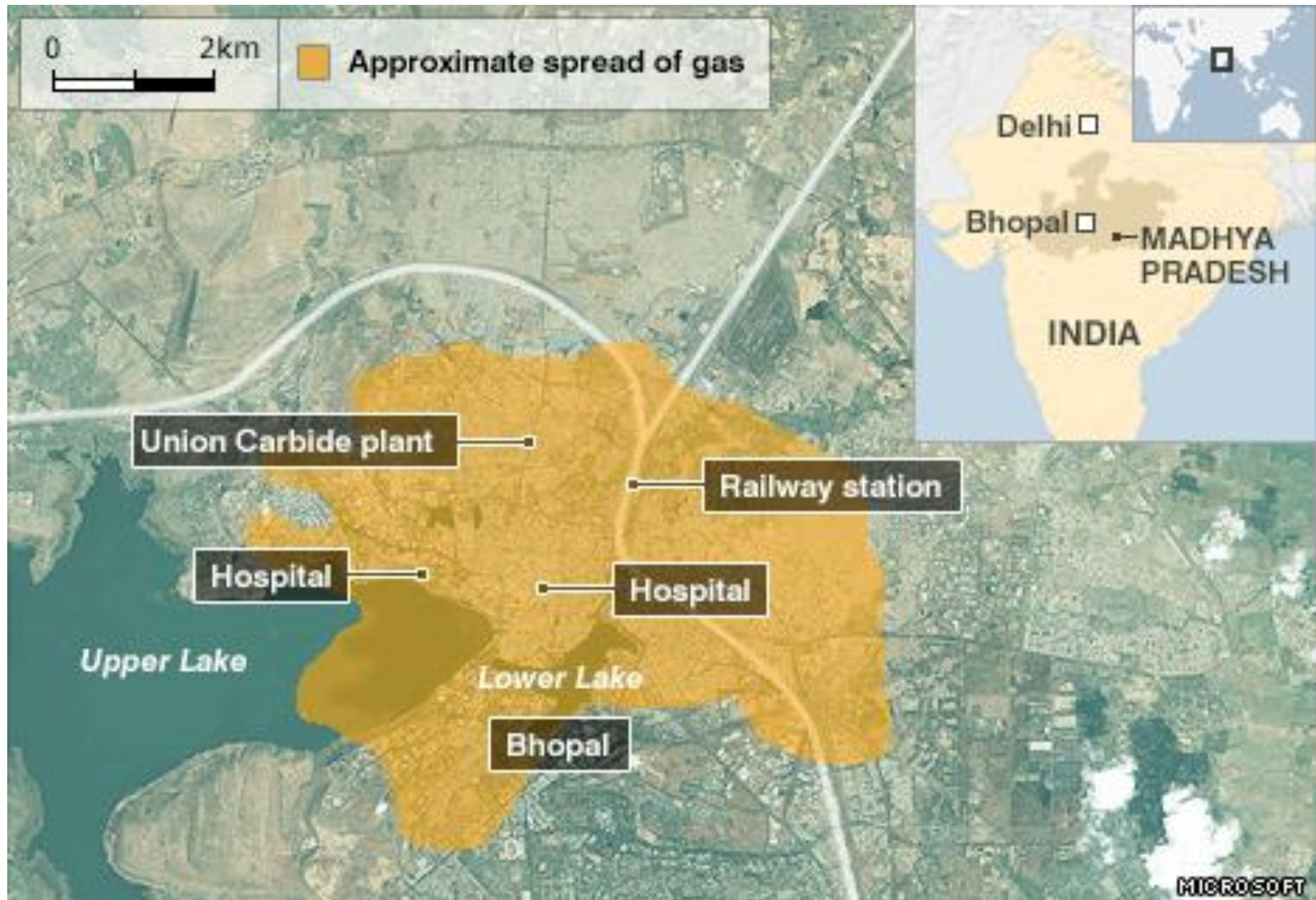
In the early morning of 03 December 1984, a gas cloud was released from the Union Carbide pesticide factory in Bhopal.

Within a few hours, thousands of people were dead and hundreds of thousands were injured

Most people agree that the release of toxic gases was caused by a runaway reaction in a tank E610 containing about 40 tonnes of methyl isocyanate after it came into contact with about one tonne of water.

There are at least four competing theories as to how this happened

Bhopal - what happened? ...the gas release and consequences





Bhopal - what happened? ...the gas release and consequences

Initial deaths (3-6 December): more than 3,000 - official toll

Unofficial initial toll: 7,000-8,000

Total deaths to date: over 15,000

Number affected: Nearly 600,000

Indian Supreme Court, Madhya Pradesh government, Indian Council of Medical Research

Bhopal - what happened? ...the gas release and consequences



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- official toll**

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Bhopal - what happened? ...main theories and factors

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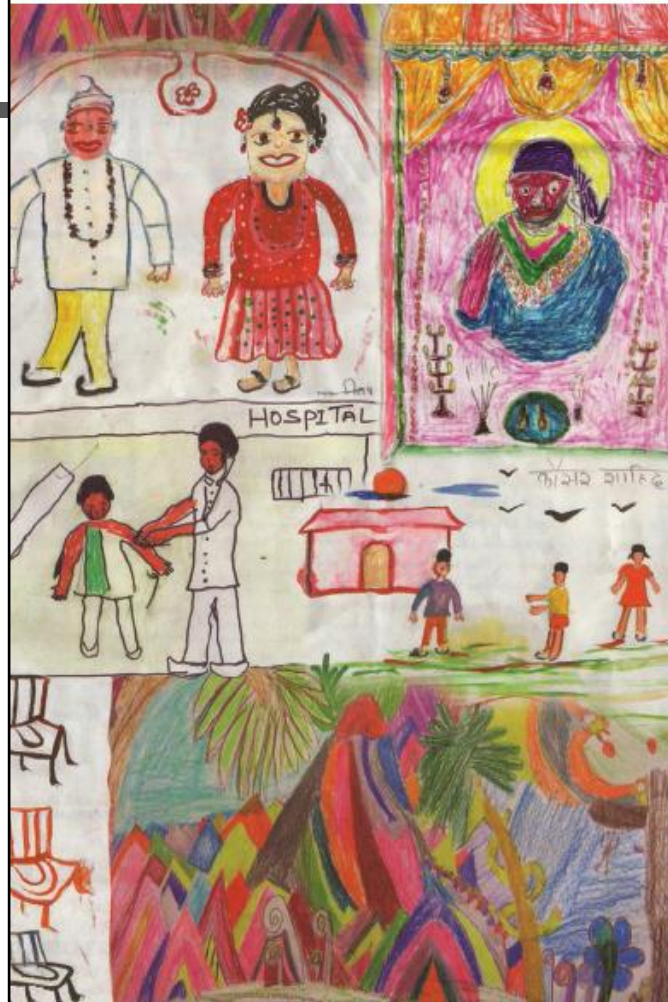
There are at least four competing theories as to how this happened:

- 1. The water washing theory**
- 2. The sabotage theory**
- 3. The decomposition theory**
- 4. The nitrogen mix up theory**

Loss Prevention Bulletin

Improving process safety by sharing experience

Issue 240, December 2014



Remembering
Bhopal –
30 years on

Bhopal - what happened?

...main theories and factors – **breached defences**

Vent gas scrubber

Leaking gas could have been detoxified, but the scrubber was turned off

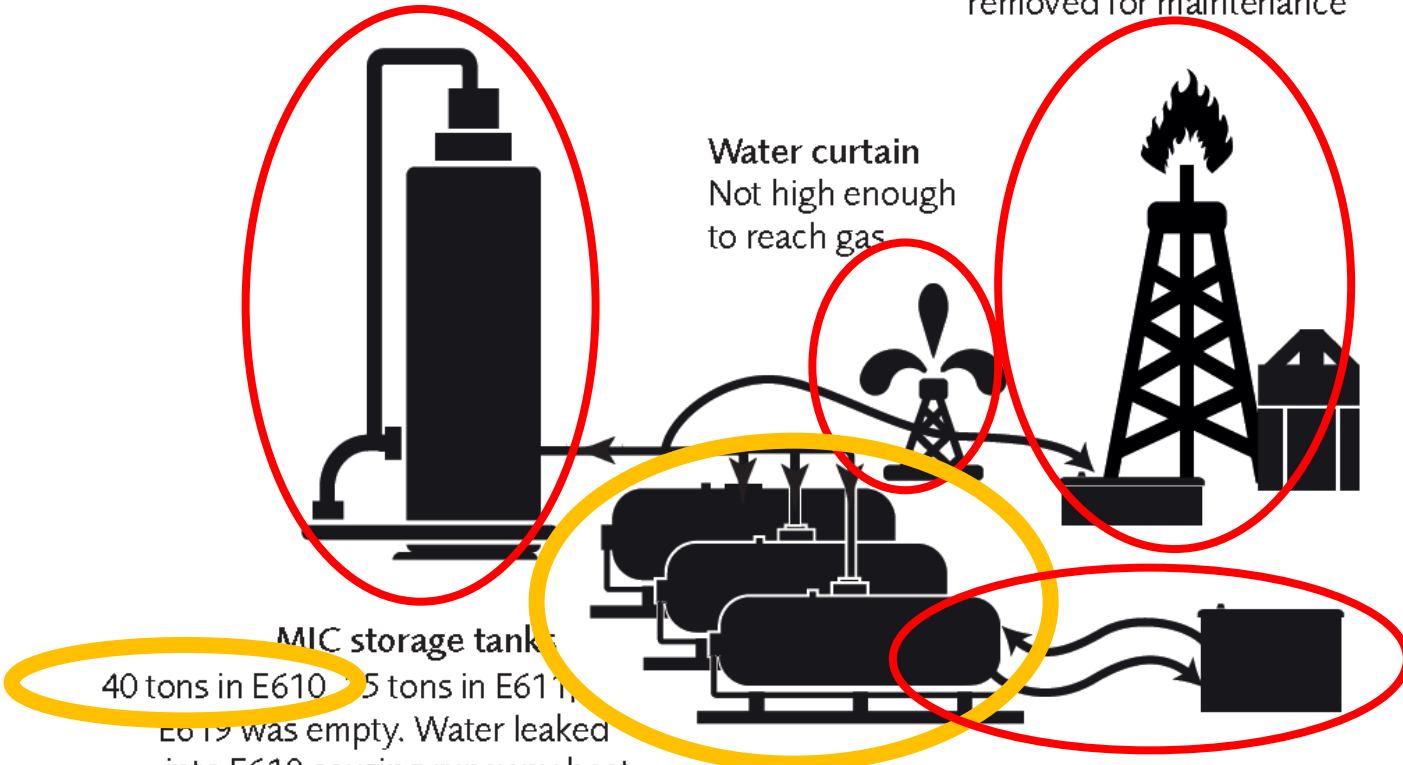
Flare tower

Designed to burn off gas, but a connecting pipe had been removed for maintenance

Water curtain
 Not high enough to reach gas

MIC storage tanks
 40 tons in E610, 5 tons in E611, E619 was empty. Water leaked into E610 causing runaway heat-producing reaction

Refrigeration system
 Freon system to cool liquid MIC was shut down in June 1984 to save money and Freon shipped to other plants





Tank 610 which contained 40 tons of MIC



The refrigeration system which was out of service



The scrubber which was out of service



The flare which was by-passed



Bhopal - what happened?

Precursors and aftermath

1982 - MIC unit started up; last American leaves; plant uneconomic...

Fall, 1984, plant operating at about 20% capacity...

Nov 1984 riots following Indira Gandhi assassination – curfew restricts plant operation

Dec 3 1984 The incident: catastrophic gas release

Dec 4 - UCC team (including CEO Warren Anderson) despatched to Bhopal

Feb 26 1985 – 10 global industry leaders asked AIChE to lead collaborative effort to eliminate catastrophic process safety incidents

Mar 23 1985 – AIChE formed the Center for Chemical Process Safety

1994 UCC sold 50.1% stake in UCIL (proceeds going to build and endow hospital)

2001 last remnants of Union Carbide were absorbed by Dow Chemical

Bhopal - what happened? ...investigations

- Indian Council of Scientific and Industrial Research - Report Dec1985
- UCC / Arthur D Little (A Kalelkar) – paper at IChemE conference May 1988
- UCC report by J Browning (UCC VP - HS&E) 1993
- CBI – no report yet issued (but 8 sentenced in 2010)

The situation in Bhopal today

Three key aspects

- Condition of the old Union Carbide site
- Soil and groundwater contamination
- Public health and social situation



Bags of formulated Sevin still left in the plant - Metal storage building corroded; now admits rainwater which carries Sevin into surface and groundwater



**Mercury - had been used in a liquid seal
Metal corroded and mercury now on ground**



'Solar Evaporation Pond' ...December 2014



'Solar Evaporation Pond'December 2014



Dwellings beside the plantDecember 2014

Medical: Professor Paul Cullinan

several community-based organisations (notably the Chingari and Sambhavna clinics) where large numbers of people from the most marginalised and needy sectors of the city are offered care in an environment of extraordinary tenderness. While there is no proof that the conditions being treated in these settings are a direct result of the 1984 accident, or from ongoing contamination from abandoned pesticide, there is no proof that they are not. In a story that has few heroes, those who tirelessly work there are worthy of our support.



Chingari Trust Children's Clinic

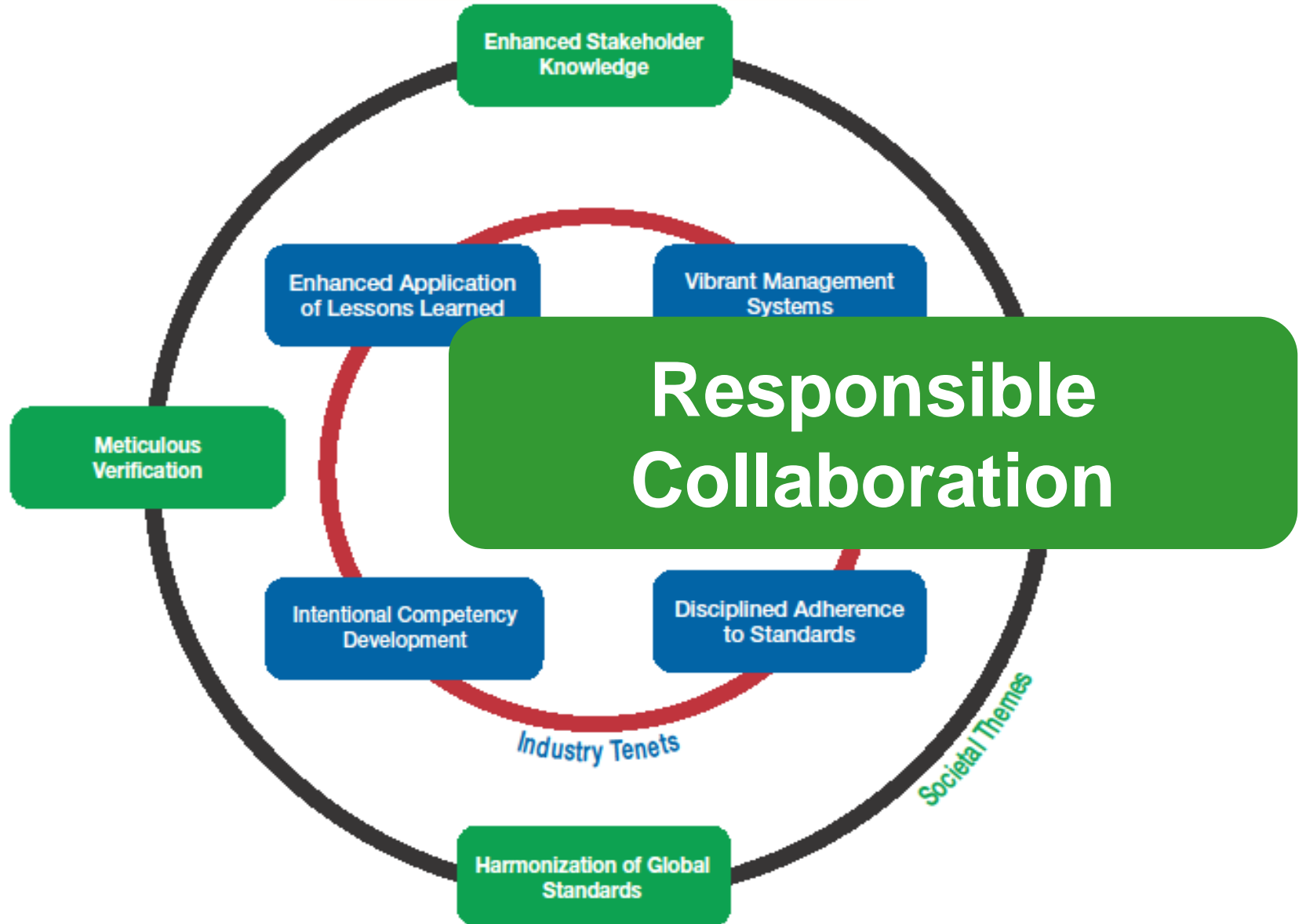


Sambhavna Clinic



Sambhavna Clinic

VISION20/20



A Call To Action

...30 years is already too long

It's time to leverage our resources, knowledge and skills to:

- **Clean up the site and surroundings**
- **Support the local affected community**

Final reflection...

Extract from Judgement, 1987 US Court of Appeals, Judge Mansfield:

“The plaintiffs seek to prove that the accident was caused by negligence on the part of UCC in originally contributing to the design of the plant and its provision for storage of excessive amounts of the gas at the plant.

As Judge Keenan found, however, UCC's participation was limited and its involvement in plant operations terminated long before the accident....

The preliminary process design information furnished by UCC could not have been used to construct the plant. Construction required the detailed process design and engineering data prepared by hundreds of Indian engineers, process designers and sub- contractors...

In short, the plant has been constructed and managed by Indians in India”

James Reason's Analysis of Latent Failures

Case Study No. 2: Bhopal

Selected latent failures

Origins

1. System errors

<p>Locating a high risk plant close to a densely populated area.</p> <p>Poor emphasis on system safety. No safety improvements after adverse audits.</p>	<p>Government/Management Management</p>
<p>No improvement in safety measures, despite six prior accidents.</p> <p>Storing <u>10 times more methyl isocyanate (MIC) than was needed daily</u>. Poor evacuation measures.</p>	<p>Government/Management Management</p>
<p>Safety measures not upgraded when plant switched to large scale storage of MIC.</p>	<p>Government/Management Management</p>
<p>Heavy reliance on inexperienced operators and supervisors.</p>	<p>Management</p>
<p>Factory inspector's warning on washing MIC lines neglected.</p>	<p>Management</p>
<p>Failure to release telex message on MIC treatment.</p>	<p>Management</p>

The last word...

There is no substitute for a mix of a competent, properly trained and fully resourced local team together with on-site head office expertise. That has costs. But if a project cannot be resourced safely, then it should not be done at all. If a plant cannot be run safely, then it should be shut down: responsibly and carefully.

Remember Bhopal.

Fiona Macleod

Back-up





Bhopal - what happened? ...Aftermath and legal action

Monday, 7 June 2010 - **A court in the Indian city of Bhopal has sentenced eight people to two years each in jail over a gas plant leak that killed thousands of people in 1984.**

The convictions are the first since the disaster at the Union Carbide plant - the world's worst industrial accident.

The eight Indians, all former plant employees, were convicted of "death by negligence". One had already died - the others are expected to appeal.

Campaigners said the court verdict was "too little and too late"

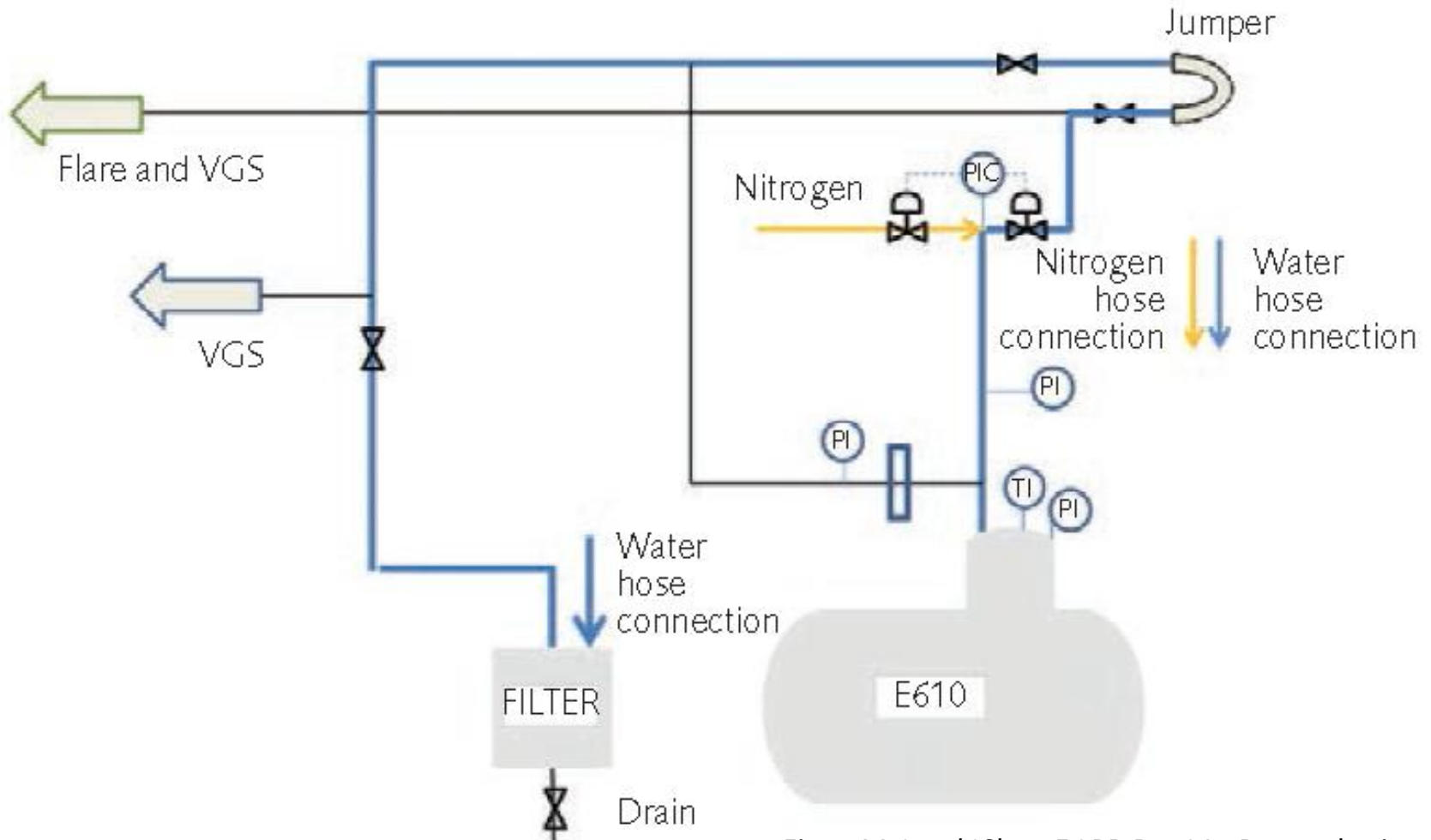
The eight convicted on Monday were Keshub Mahindra, the chairman of the Indian arm of the Union Carbide (UCIL); VP Gokhale, managing director; Kishore Kamdar, vice-president; J Mukund, works manager; SP Chowdhury, production manager; KV Shetty, plant superintendent; SI Qureshi, production assistant. All of them are Indians.

The seven former employees, some of whom are now in their 70s, were also ordered to pay fines of 100,000 Indian rupees (£1,467; \$2,125) apiece.

http://news.bbc.co.uk/2/hi/south_asia/8725140.stm

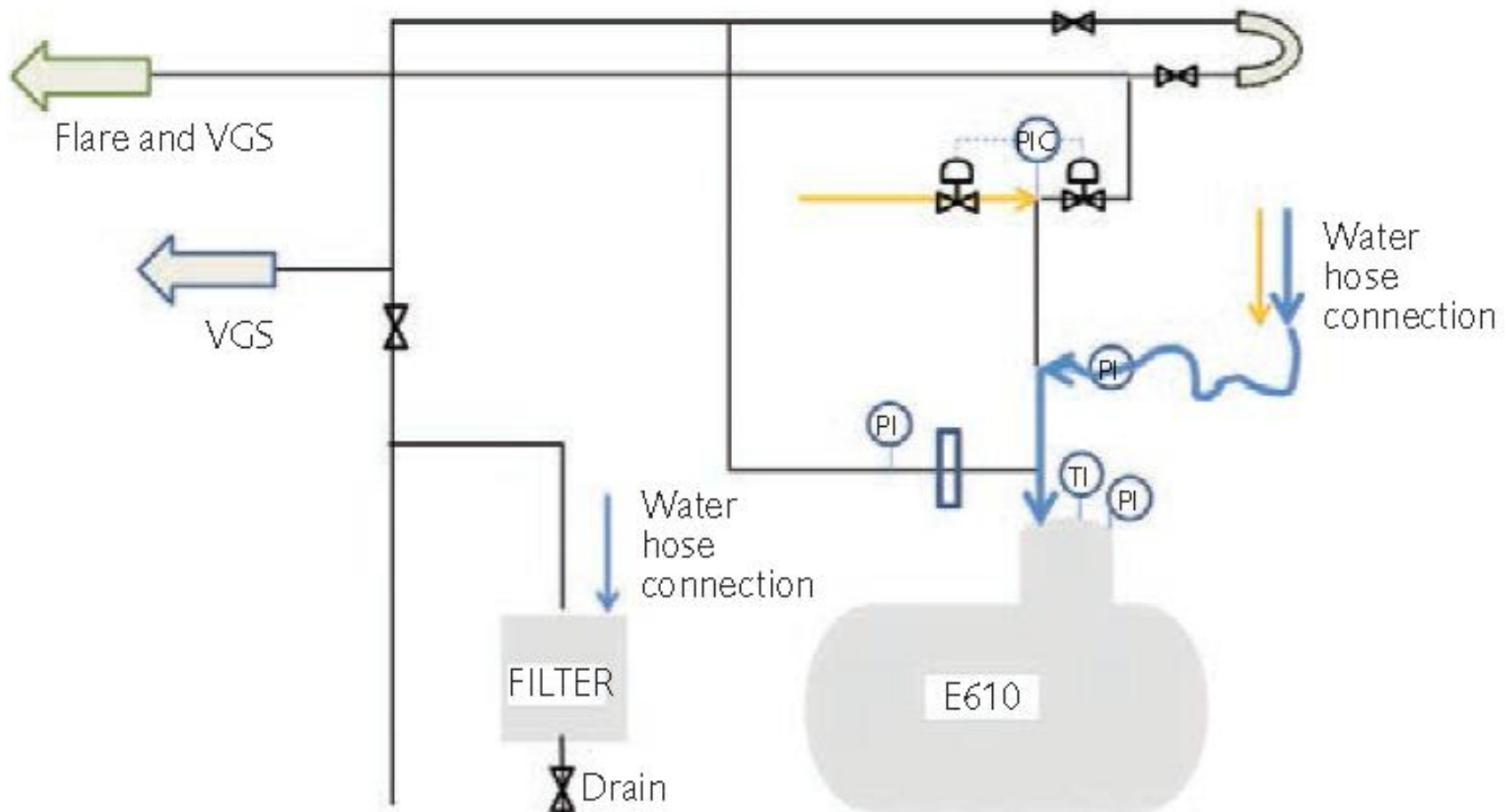
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1 - The water washing theory



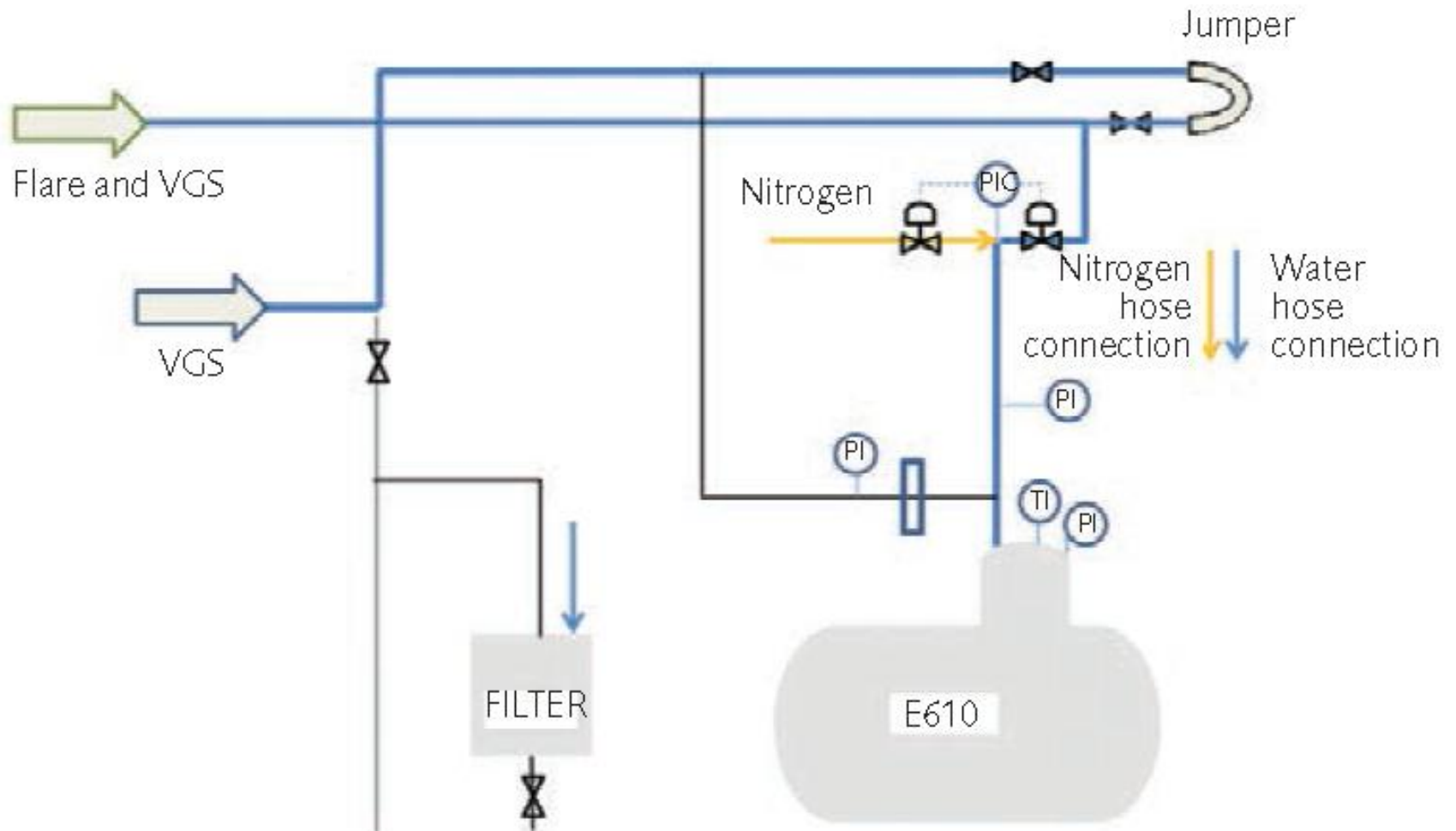
Bhopal - what happened? ...main theories and factors

2 - The sabotage theory



Bhopal - what happened? ...main theories and factors

3 - The decomposition theory



Bhopal - what happened? ...main theories and factors

4 - The nitrogen mix up theory

