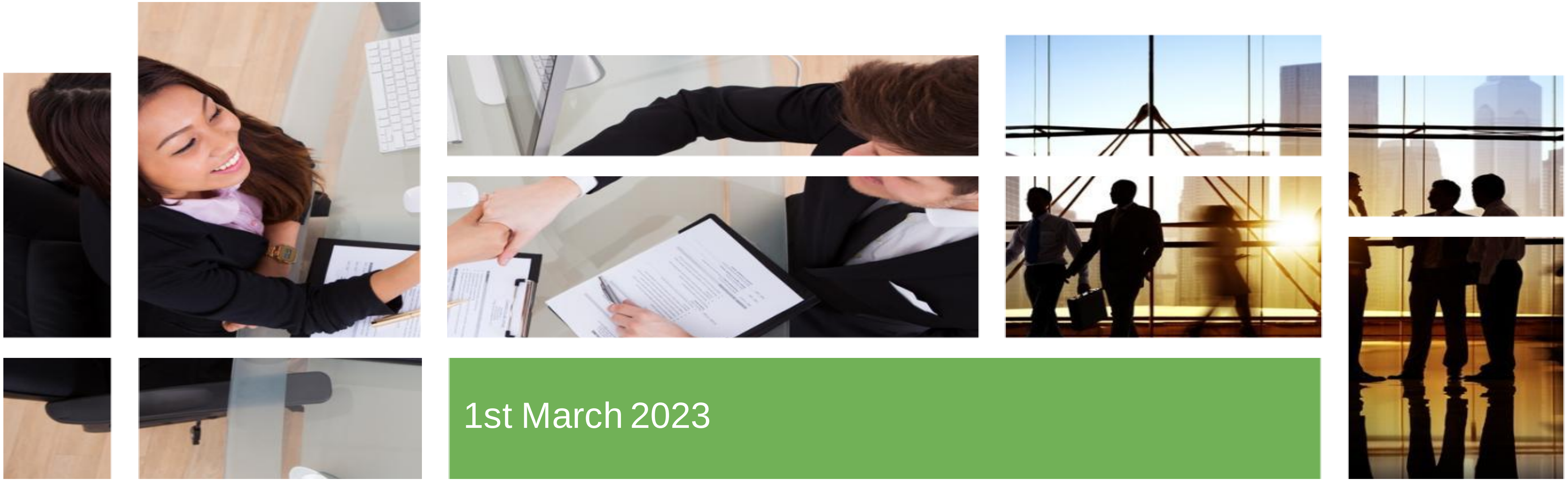
IChemE ADVANCING CHEMICAL ENGINEERING WORLDWIDE

IChemE Water Special Interest Group

IChemE Safety & Loss Prevention Special Interest Group

Process Safety in the Water Industry

Safety & Loss Prevention and Water SIG Collaboration Webinar



1st March 2023

Welcome

Presenters

- **Kirsty McCall** MSci, CEng CSci MIChemE, Regional Process Discipline Lead, MWH Treatment
- **Christopher Taylor,** Senior Process Engineer, United Utilities Group PLC
- **Ken Patterson,** Member of IChemE's Major Hazards Committee and Loss Prevention Panel
- **Peter Marsh** BSc, CEng MIChemE; Director of XBP Refining Consultants Ltd.
- **Steve Murphy** PhD, MIChemE; Head of Process Safety for Syngenta Group.

Housekeeping

- Questions – in chat box, or in person during the designated question times?
- We will leave space at the end for questions

Agenda

Time	Agenda Item	Duration
09:00	Start / Welcome	5 mins
09:05	Process Safety in the Water Industry (Kirsty McCall)	5 mins
09:10	Municipal water disasters – a role for process safety (Ken Paterson)	15 mins
09:25	Q&A	10 mins
09:35	Incidents in the water and other industries (Peter Marsh)	10 mins
09:45	Hazard spotting with study 1- applies to a change and links to other 5 stages (Steve Murphy)	15 mins
10:00	Q&A	15 mins
10:15	Finish	

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Kirsty McCall

Process Safety in the Water Industry

Process Safety in the Water Industry

Why is process safety important?

Personal safety	Process safety
• Low severity • High frequency • Slips, trips & falls	• High severity • Low frequency • Plant (hardware), process (systems), people

"Process safety hazards are less intuitive, so hazard identification techniques need to be structured."

P. Eames, The Chemical Engineer, December 2018

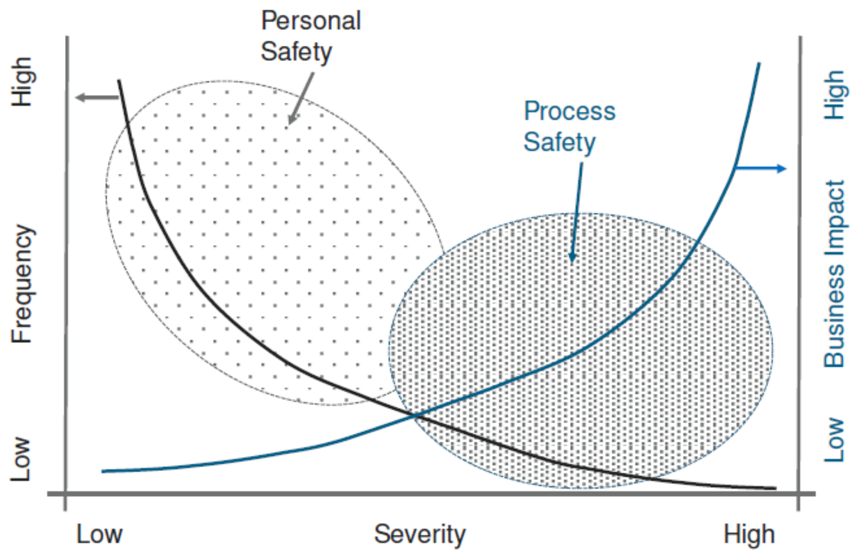

Image credit: IChemE Fundamentals of Process Safety training course, presented by Tracey Kelly & Andrew Hudson, 2017

Process Safety in the Water Industry

Process safety incidents within the water industry

Abbeystead (1984) – methane explosion - 16 fatalities

Camelford (1988) – contamination of final water – 20,000 homes affected

Avonmouth (2020) – sludge tank explosion – 4 fatalities

Process Safety in the Water Industry

What are the biggest risks to process safety?

Top risks (as identified by the Water SIG membership):

1. Consequences of abnormal operation and identifying suitable safeguards
2. Lack of maintenance and knowing when to react
3. Change management (lack of)
4. Handling chemicals

How can we prevent process safety incidents?

- Carry out the appropriate hazard studies at the right time with the right people
- Share examples of when things go wrong!

What can Process Safety do for the Water Industries?

Harare & Flint Water disasters

Dr Ken Patterson

Harare and Flint Water Disasters

Process safety

In IChemE's FOPS course we define Process Safety as :

"A systematic framework for the management of the integrity of ~~hazardous processes"~~ processes with significant hazardous consequences

"
i

We think of "Hazardous Processes" when we think of Major Accidents: Flixborough, Chernobyl, Toulouse, Deepwater Horizon - and we don't think of water supply or disposal as "hazardous processes".

However, urban society is totally dependent on service supply, and the effects of maloperation can be huge, which suggests a change to the definition:

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Process safety

The extended definition could have significance more generally.

Society is increasingly reliant on services to function:

- Loss of electrical power takes out light, heat and communication
- Loss of gas takes out heat and power
- Loss of internet connection makes smart houses and "the internet of things" in-operable

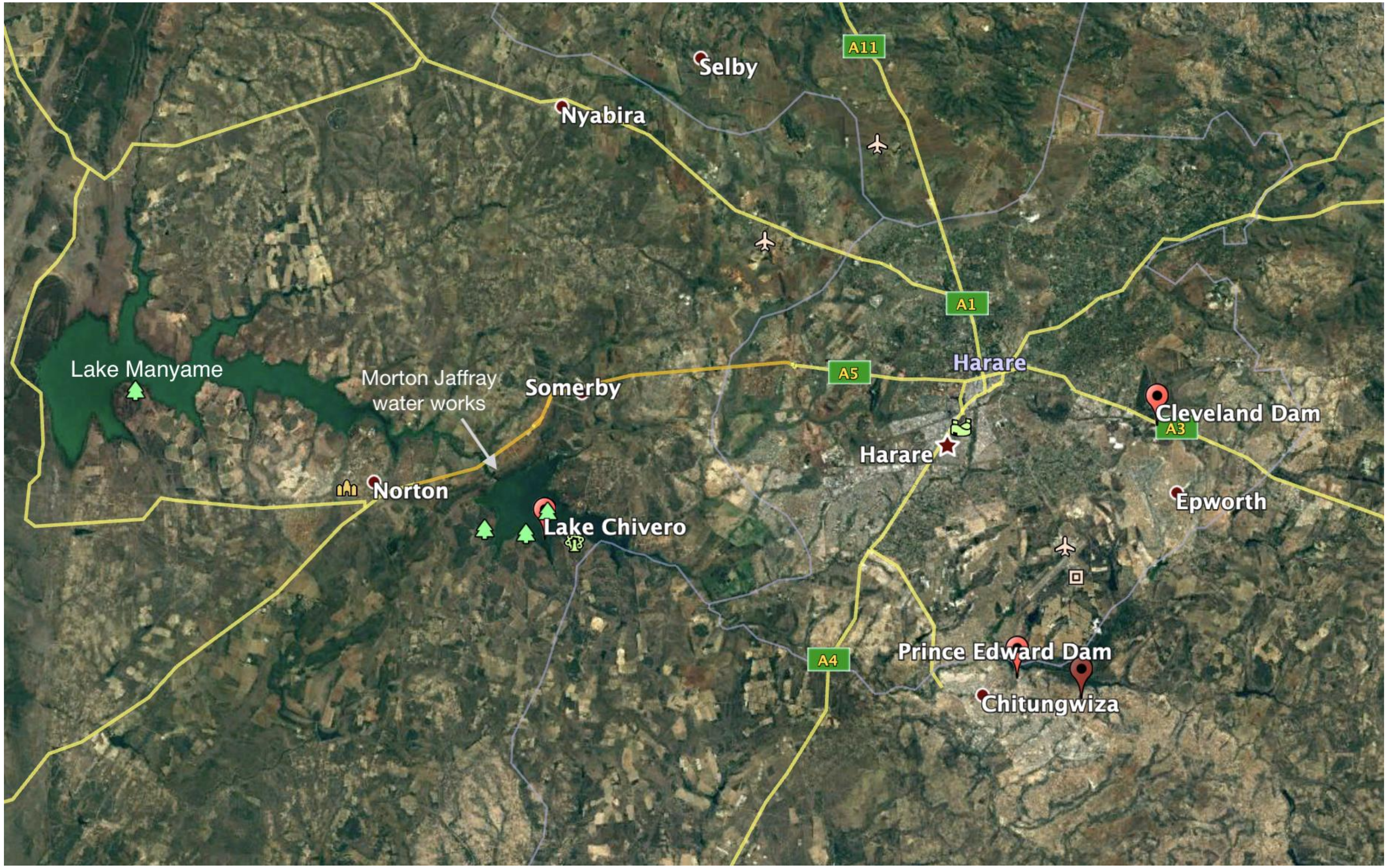
Across the world, water system failures have probably killed more people than Process Safety failures in this century

Harare - thousands & Flint - hundreds(?)

Harare - background

- Capital of Zimbabwe
- Water system (clean & foul) built for pop. of 150,000
- Extended to give capacity for ~600,000
- Current pop. 1,500,000 - 2,200,000
    - Significant part of the population is “informal”
- City is at ~1,450m, has surrounding hills & some rivers
- Majority of the water supply comes from 2 large lakes (reservoirs): Chivero - 35 km away and 100m below the city; & Manyame - 50 km away & 125m below city
- The City’s sewage system runs into the rivers which feed the lakes

Harare - surroundings



Picture from Google Earth dated March 2019

Harare - problems

1. The area surrounding the lakes is agricultural, run off from this can be rich in phosphate
2. Sewage system has frequent overloading, allowing untreated effluent to flow into the rivers & lakes
   - Algal bloom, water hyacinth, poor water quality
3. Economic collapse (GDP -10% pa), inflation 10^9% pa
4. Water supply breakdowns & “diversion”
   - Shallow wells dug, lack of sanitation - polluted wells
   - Lack of treatment chemicals; prolonged plant outages
5. Lack of clean water even to hospitals
   - 2008 Cholera:10,000 cases, 4,000 deaths
   - 2012 Typhoid: 3,000 cases; 2017 Diarrhoea: 50,000 cases

Flint - background 1

- Home of General Motors, 80,000 jobs in the car industry
- City develops from early 1900s, services built as city grows, prosperous until 1970s, pop ~200,000
- In the 1950s, clean water supply switched to Detroit system ~100 km away. Existing plant mothballed
- Flint severely hit by contraction in car industry, jobs fall to 8,000 by 2000, population falls to ~100,000
- By 2000 Detroit also has financial problems and price of water begins to rise
- Flint population now smaller & poorer but the City has all the existing municipal debt and services to pay for. Flint becomes effectively bankrupt by 2010

Flint - background 2

- "City Manager" appointed by the State Governor in 2011
    - Powers to over-ride council
    - Remit to cut costs - including cost of water
- As an interim measure decides to re-start mothballed plant, which takes water from polluted, acidic Flint River
- No experienced personnel, responsible manager opposes re-opening, says plant is not ready to start
- Decision taken not to add phosphate inhibitor, to save $140 per day ($50k pa)
- Plant restarted in April 2014 ……

Case study: Flint, Michigan 2014

Video by VOX - 3:36: https://youtu.be/NUSiLOwkrIw

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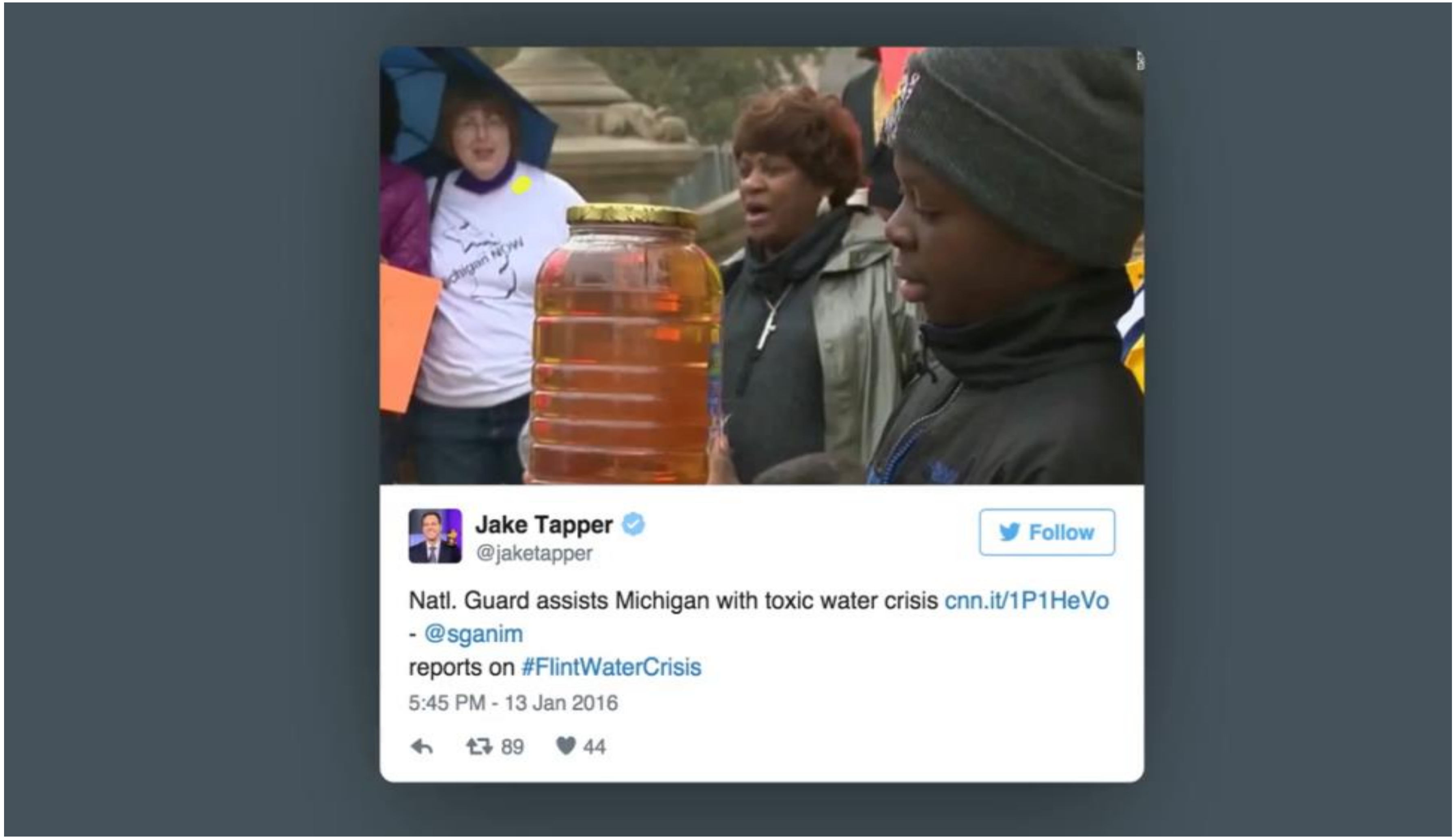
Case study: Flint, Michigan 2014



Flint - problems

1. Water produced is not colourless, tasteless & odourless
   - ➞ Very large use of bottled water & installation of water filters
2. Lack of inhibitor means calcite scale on existing, old pipes erodes away
   - ➞ Lead pipes begin to dissolve, rust inside cast iron pipes is attacked
3. Poor quality water now contains e-coli
   - ➞ Chlorine addition increased, which in turn:
     - ➞ Increases conc. of Pb in water; infant Pb exposure and increase in perinatal deaths
     - ➞ Attacks rust in iron pipes releasing legionella, 10-100 deaths
     - ➞ Leakage increases sharply, local distribution pipes destroyed

Flint - problems 2

1. General Motors engine plant has problems with rusting, traced to acidic water supply
    - ➞ GM switches back to Detroit water in October 2014
2. Residents complain of water quality
    - ➞ Advised to boil water from August 2014
    - ➞ Sept 2015: Virginia Tech study suggests 40% of Flint homes have elevated PB levels in their water
        - ➞ Study says Flint water not safe for drinking or cooking
    - ➞ Sept 2015: paediatrician's study shows sharp increase in the number of children with high Pb levels
    - ➞ Oct 2015: Flint switches back to Detroit water at a cost of $9.35m

Flint - aftermath

1. Loss of confidence in system & government
   - ➞Many residents still apparently refuse to drink Flint water (thought it is now safe according to current testing)
   - ➞Houses in Flint are estimated to have fallen in value by >$500m
2. Large part of Flints local water distribution system, including inside properties were wrecked and needed to be replaced
   - ➞On-going, current bill estimated to be >$500m (estimated up to $1500m)
3. Civil case against State of Michigan by residents of Flint
   - ➞ Settled in December 2021 for $626m
4. Criminal indictments against Michigan Governor Snyder el al, and against the City Managers; also against officials of Michigan Department of Environmental Quality, The US EPA, Michigan state Health Authority, and against officials of the Flint municipal authority.

A role for Process Safety?

- The problems in both Harare and Flint should have been clear to competent people with experience in the water supply and sewage treatment industries:
  - There does not seem to be any “new knowledge” which comes out of either case
  - I guess most people in the water industry will be thinking: “How *could* they do that?”
- These are only 2 cases but the number of deaths probably dwarfs the number killed by process industry process accidents since 2000
- Common process safety techniques; Hazid/Envid and Hazop studies, Management of Change control (mandatory under the Seveso 3 directive), and What-if techniques should all have held up “red flags” about the actions (proposed to be) taken
- Should we implement a PSM system for Water? How should/could we do it?

Reference & Contact

- There is a Loss Prevention Bulletin paper on Flint and Harare: "Municipal water disasters - a role for process safety?", in the June 2020 edition.

The article contains a number of references to the source material on both events.

LPB is free to access for all IChemE members.

- The Flint water disaster was discussed in one episode of the National Geographic TV series "Disasters engineered".

- There are a number of other short Vox videos on YouTube which discuss the Flint water crisis and especially the political implications of what happened.

- KJ.Patterson@NTLworld.com

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Questions?

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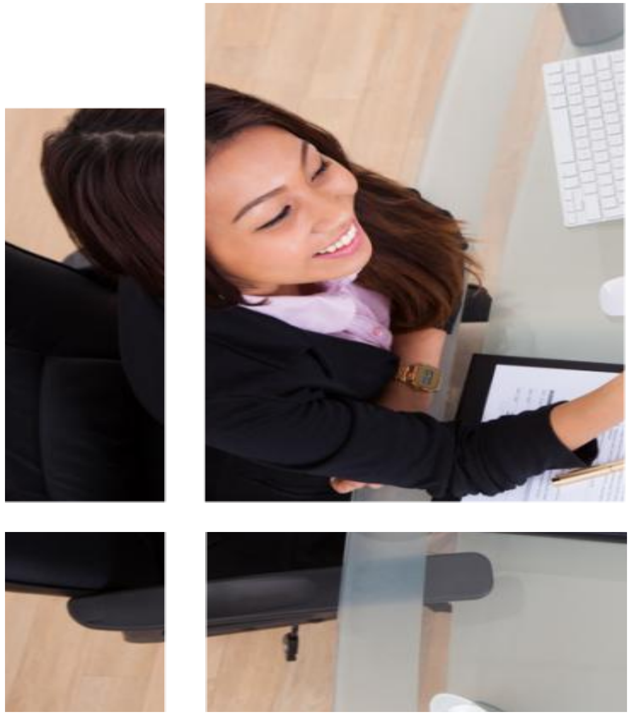


Peter Marsh

Learning From Past Incidents

Learning From Past Incidents

Peter Marsh BSc CEng MIChemE

1979-1980 Process Systems Engineer, Esso Fawley Refinery (UK)

1981-1982 Process Engineer, BP Isle of Grain Refinery (UK)

1982-1986 Process Engineer, BP Grangemouth Refinery (UK)

1987-1988 Operations Supervisor, BP Grangemouth Refinery (UK)

1988-1991 Lead Process Engineer, Davy McKee Pacific (Australia)

1992-1994 FCC Process Specialist, BP Sunbury (UK)

1995-1998 FCC Principal Specialist, BP Kwinana Refinery (Australia)

1998-2003 Technical Support Engineer, BP Coryton Refinery (UK)

2003-2004 Process Development Leader, BP Coryton Refinery (UK)

2005-2015 Advisor - Reforming/Isomerisation, BP Sunbury (UK)

2015-Now Director, XBP Refining Consultants Ltd (UK)

2017-Now Committee Member, IChemE Safety & Loss Prevention SIG

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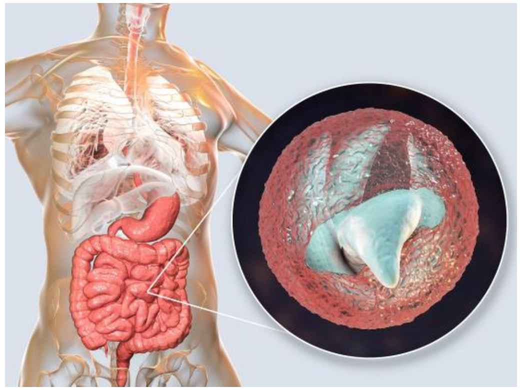
Learning From Past Incidents

Abbeystead

- 16 killed
- 28 injured
- HazID (CH_4)

Milwaukee



- 69 killed
- ~403,000 sick
- Process design

Bethune Point

- 2 killed
- 1 injured
- HazID (MeOH)

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Learning From Past Incidents

“It might seem to an outsider that industrial accidents occur because we do not know how to prevent them. In fact they occur because we do not use the knowledge that is available.

Organisations do not learn from the past or, rather, individuals learn but they leave the organisation, taking their knowledge with them, and the organisation as a whole forgets.”

Kletz: “Lessons from Disasters. How organisations have no memory and accidents recur.” Institution of Chemical Engineers. 1993 ISBN 0 85295 307 0

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Learning From Past Incidents

- Maintain corporate memory
- Raise awareness
- Share lessons
- No shame in sharing
- Improve risk management
- Improve safety performance
- Avoid recurrence
- Save lives, prevent illness or injury

Learning From Past Incidents

Abbeystead 1-Pager

Lessons Learned Database
Individual Incident Summary Report

Incident Title	**Water Pumping Station Explosion**
Incident Type	Explosion
Date	23rd May 1984
Country	UK (England)
Location	Abbeystead (Lancashire)

Fatalities	Injuries	Cost
16	28	Unknown

Incident Description


Credit: ANL/Shutterstock

On the evening of the incident, a group of 44 visitors were attending a public consultation meeting which had been set up to allay local residents' concerns that water pumped into the River Wyre via the Lune/Wyre River Transfer Link Scheme may have aggravated winter flooding in the lower Wyre Valley. (The scheme was built to meet anticipated future increases in water demand in the region through the 1980s). The meeting was held in a Valve House set into a hillside at the Abbeystead Outfall Station located at the outfall end of the link. The meeting included a demonstration of the station's operation with water being pumped over the weir regulating the flow of water into the River Wyre. Shortly after pumping commenced, with the visitors congregated in the Valve House, there was an intense flash, followed immediately by an explosion which caused severe damage to the Valve House and fatally injured 16 people. Some were killed by the explosion, some by roof collapse and some by drowning (the steel mesh floor collapsed, throwing victims into the water chambers below which rapidly flooded with river water).

Incident Analysis

Basic cause was a confined space explosion caused by accidental ignition of methane (CH_4) gas from a coal seam 1200 m below which had been displaced from the Wyresdale Tunnel into the Valve House at the Abbeystead Outfall Station as the water level in the tunnel rose after pumps were started at the upstream Lune Pumping Station.

Critical factors included: 1) The Lune/Wyre transfer system had not been operational for 17 days before the explosion, 2) A washout valve had been left permanently open at a low point in the Abbeystead Outfall end of the Wyresdale Tunnel to avoid silt accumulation beyond the Valve House (the resulting water loss led to a void forming in the normally water-filled tunnel), 3) The Wyresdale Tunnel had been cut through a complex network of geological faults and had a concrete (porous) lining, 4) The tunnel high point vents were ducted to the underground Valve House at the Abbeystead Outfall Station, 5) Smoking was not prohibited in the Valve House.

Root causes included: 1) Inadequate hazard identification (CH_4 presence in Valve House not anticipated), 2) Inadequate design (water discharge system vented to underground room with limited natural ventilation), 3) Absence of gas detection equipment (due to inadequate hazard identification), 4) Violation of operating procedures (washout valve left open), 5) Inadequate management of change (flush procedure using washout valves).

Lessons Learned

1) Methane solubility in water increases with pressure, 2) Methane gas can be evolved from groundwater and in water boreholes, 3) Systems conveying water should be designed such that any gas evolved is vented to a safe location in the open air.

More Information

1) "The Abbeystead Explosion: a report of the investigation by the Health and Safety Executive into the explosion on 23 May 1984 at the valve house of the Lune/Wyre Water Transfer Scheme at Abbeystead", Her Majesty's Stationery Office, ISBN 0-11-883795-8.
2) "What Went Wrong? Case Histories of Process Plant Disasters and How They Could Have Been Avoided", 4th Edition (1999), Trevor Kletz, Elsevier, ISBN-10: 0 88415-920-5, ISBN-13: 978-0-88415-920-9.
3) Incident Overview: https://en.wikipedia.org/wiki/Abbeystead_disaster.

Industry Sector	Process Type	Incident Type
Water	Water Distribution	Explosion
Equipment Category	**Equipment Class**	**Equipment Type**
Not equipment-related	Not applicable	Not applicable

Learning Lessons from Major Incidents
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Milwaukee 1-Pager

Lessons Learned Database
Individual Incident Summary Report

Incident Title	**Public Water Supply Contamination**
Incident Type	Waterborne Disease
Date	5th April 1993
Country	USA
Location	Milwaukee, WI

Fatalities	Injuries	Cost
69 – Ref. 2	~ 403,000 – Ref. 1	US$ 96 m (2003) – Ref. 3

Incident Description


Credit: Kateryna Kon/Shutterstock

Milwaukee city water is sourced from Lake Michigan and supplied by 2 water treatment plants (WTPs); Linwood WTP on the north side and Howard Avenue WTP on the south side. The treatment process at both involved adding chlorine (disinfectant) and polyaluminium chloride (coagulant), rapid mixing, mechanical flocculation, sedimentation and rapid sand filtration. The treated water was stored in a large clearwell before entering the distribution network. The filters were backflushed with treated water which was then recycled through the WTP. On 5th April 1993, widespread gastrointestinal illness and significant school and workplace absenteeism was reported among Milwaukee residents. A survey of diarrhoea cases in local nursing homes (geographically fixed populations) and testing of infected resident's stools for cryptosporidium revealed that the outbreak was concentrated on the south side. These results coupled with discovery of treated water turbidity problems at the Howard Avenue WTP over the preceding 2 weeks suggested that drinking water supplied by the Howard Avenue WTP could be implicated. The plant was shut down and the city mayor issued a boil water advisory.

Incident Analysis

Basic cause was breakthrough of cryptosporidium oocysts to finished water due to inadequate filtration at the Howard Avenue WTP. (Cryptosporidium oocysts are tiny protozoan parasites which can cause severe or fatal gastrointestinal illness, especially in immunodeficient people.)

Critical factors included: 1) Cryptosporidium oocysts are 3 - 6 µm diameter and highly resistant to chlorine (coagulation and filtration control crucial), 2) Severe spring storms (high source water turbidity and microbial load), 3) Turbidity of finished water was only measured every 8 hours (the minimum allowed by authorities), 4) Rapidly changing source water quality, long sampling lag time and limited operating history with polyaluminium chloride (replaced aluminium sulphate in Sep-92) made dosage optimisation difficult.

Root causes included: 1) Inadequate monitoring (testing for turbidity and cryptosporidium oocysts ineffective), 2) Inadequate process design (recycling filter backwash effluent without extra treatment), 3) Inadequate training (WTP operators), 4) Inadequate/inconsistent state water quality standards.

Lessons Learned

1) Filter backflush effluent recycling was discontinued at both WTPs (to break the "concentration loop"), 2) Continuous turbidity monitoring with alarms and automatic shutdowns was installed at each filter in both WTPs, 3) Ozonation units were installed at both WTPs to improve disinfection, 4) Procedures for turbidity monitoring and cryptosporidium sampling/testing in both source and finished water were improved and standardised across the industry, 5) Filter backflush effluent requires additional treatment (e.g. lamella sedimentation) before recycling, 6) For WTPs where cryptosporidium breakthrough risk is high, additional disinfection (e.g. ozonation, ultra-violet irradiation) is required.

More Information

1) "Cryptosporidium and the Milwaukee Incident", K. Fox and D. Lytle, US Environmental Protection Agency, Report No. EPA/600/A-94/251 (1994).
2) "Lessons from Waterborne Disease Outbreaks", Institute of Medicine (US) Forum on Microbial Threats, Washington (DC), National Academies Press (2009): https://www.ncbi.nlm.nih.gov/books/NBK28459/#ch2.s10.
3) "Costs of Illness in the 1993 Waterborne Cryptosporidium Outbreak, Milwaukee, Wisconsin", P.S. Corso et al, Emerging Infectious Diseases Journal Volume 9 (2003): https://dx.doi.org/10.3201/eid0904.020417.

Industry Sector	Process Type	Incident Type
Water	Water Treatment	Waterborne Disease
Equipment Category	**Equipment Class**	**Equipment Type**
Mechanical	Filters and Strainers	Sand Filter

Learning Lessons from Major Incidents
IChemE Centenary Edition (2022)
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Peter Marsh
IChemE Safety & Loss Prevention SIG

Bethune Point 1-Pager

Lessons Learned Database
Individual Incident Summary Report

Incident Title	**Methanol Tank Explosion During Maintenance**
Incident Type	Explosion and Fire
Date	11th January 2006
Country	USA
Location	Bethune Point, FL

Fatalities	Injuries	Cost
2	1	Unknown

Incident Description


Credit: City of Daytona Beach/US CSB

The Bethune Point municipal wastewater treatment plant (WWTP) was modified in 1993 to include an anoxic biological nutrient removal (BNR) process to reduce discharge of harmful nitrates that promote algae growth in receiving waters. This involved continuous injection of methanol (MeOH) as a carbon source for the bacteria which convert nitrates into nitrogen gas. The WWTP was modified again in 1999 to enable operation without continuous MeOH feed, but the injection system was retained for sporadic MeOH addition.

On 11-Jan-06, 3 workers were removing a hurricane-damaged roof shading the partially full 37.9 m^3 (10,000 US gal) capacity carbon steel above-ground MeOH storage tank. The roof was approx. 9 m (30 ft) above ground level. Two mechanics were on a man-lift basket cutting the metal roof directly above the tank vent while a crane operator was holding the roof sections as they were being cut. Sparks showering from the cutting torch accidentally ignited MeOH vapour escaping from the tank vent, creating a fireball on top of the tank. The fire propagated through a defective flame arrester on the tank vent, igniting the MeOH/air mixture inside the tank, resulting in an explosion. The explosion caused multiple MeOH piping failures and a large fire ensued engulfing the 3 workers. Two of the workers were killed and the other was critically injured.

Incident Analysis

Basic cause was ignition of methanol (MeOH) vapour by falling sparks from an oxy-acetylene torch used to cut and remove a roof from above the tank.

Critical factors included: 1) MeOH vapour is highly flammable, 2) The MeOH system had been specified with (non fire-resistant) polyvinyl chloride (PVC) piping, valves and fittings, 3) The flame arrester internals and housing were aluminium (MeOH corrodes aluminium), 4) No risk assessment was carried out during the non-routine (roof removal) work planning process, 5) No flammable gas monitoring was done before or during execution of the work.

Root causes included: 1) Inadequate awareness of MeOH hazards (flammability and incompatibility with aluminium), 2) Inadequate equipment design (MeOH piping system and flame arrester materials of construction), 3) Failure to comply with design standards (NFPA 30 required all storage tank valves to be steel), 4) Inadequate maintenance of safety-critical equipment (flame arrester), 5) Inadequate supervision (failure to conduct risk assessment), 6) Inadequate control of work (absence of hot work permit and flammable gas monitoring), 7) Inadequate training (MeOH hazards).

Lessons Learned

1) The likelihood of ignition may be reduced by using an inherently safer cold work method (e.g. cutting with a water-cooled pneumatic-powered saw) instead of a hot work method (e.g. cutting with an oxy-acetylene torch) and by placing fire blankets below the roof to contain any sparks.
2) The likelihood of a fire/explosion may be reduced or eliminated by isolating, draining and removing flammable vapours from the tank before work begins.

More Information

1) "Methanol Tank Explosion and Fire", US Chemical Safety and Hazard Investigation Board, Report No. 2006-03-I-FL (2007).
2) "Seven Key Lessons to Prevent Worker Deaths during Hot Work in and Around Tanks", US Chemical Safety and Hazard Investigation Board (2010).
3) INDG 370: "Controlling Fire and Explosion Risks in the Workplace", UK Health & Safety Executive (2013): https://www.hse.gov.uk/pubns/indg370.pdf.
4) NFPA 30: "Flammable and Combustible Liquids Code", US National Fire Protection Association (2021).

Industry Sector	Process Type	Incident Type
Water	Wastewater Treatment	Explosion & Fire
Equipment Category	**Equipment Class**	**Equipment Type**
Mechanical	Vessel	Storage Tank

Rev. 0
10-Feb-23
Page 1 of 1
Peter Marsh
Director – XBP Refining Consultants Ltd

- Incident summaries for all levels of organisation

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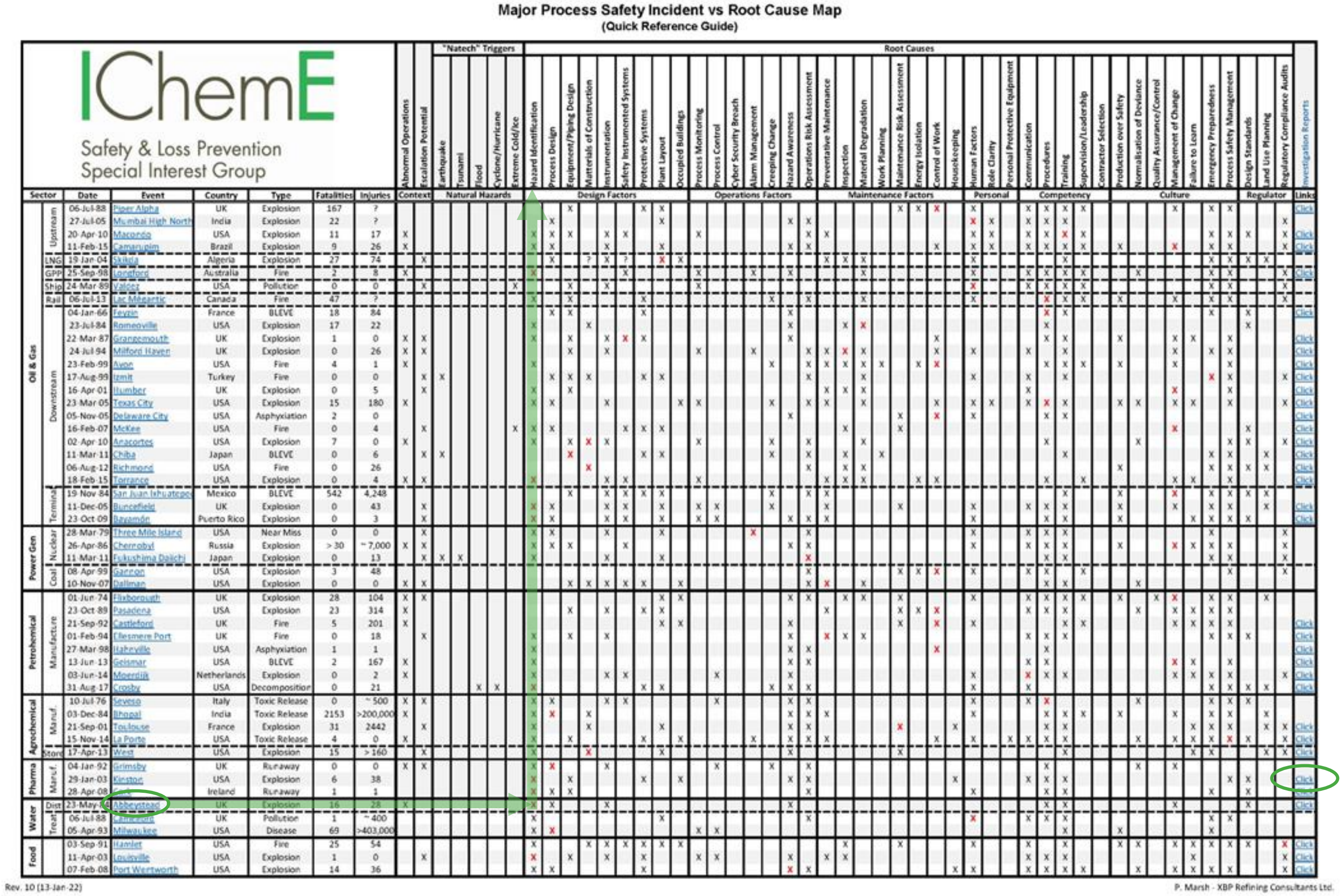
Learning From Past Incidents

Major Process Safety Incident vs Root Cause Infographic



Major Process Safety Incident vs Root Cause Map
(Quick Reference Guide)

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Sector		Date	Event	Country	Type	Fatalities	Injuries
Oil & Gas	Upstream	06-Jul-88	Piper Alpha	UK	Explosion	167	?
		27-Jul-05	Mumbai High North	India	Explosion	22	?
		20-Apr-10	Macondo	USA	Explosion	11	17
		11-Feb-15	Camarupim	Brazil	Explosion	9	26
	LNG	19-Jan-04	Skikda	Algeria	Explosion	27	74
	GPP	25-Sep-98	Longford	Australia	Fire	2	8
	Ship	24-Mar-89	Valdez	USA	Pollution	0	0
	Rail	06-Jul-13	Lac Mégantic	Canada	Fire	47	?
	Downstream	04-Jan-66	Feyzin	France	BLEVE	18	84
		23-Jul-84	Romeoville	USA	Explosion	17	22
		22-Mar-87	Grangemouth	UK	Explosion	1	0
		24-Jul-94	Milford Haven	UK	Explosion	0	26
		23-Feb-99	Avon	USA	Fire	4	1
		17-Aug-99	Izmit	Turkey	Fire	0	0
		16-Apr-01	Humber	UK	Explosion	0	5
		23-Mar-05	Texas City	USA	Explosion	15	180
		05-Nov-05	Delaware City	USA	Asphyxiation	2	0
		16-Feb-07	McKee	USA	Fire	0	4
		02-Apr-10	Anacortes	USA	Explosion	7	0
		11-Mar-11	Chiba	Japan	BLEVE	0	6
		06-Aug-12	Richmond	USA	Fire	0	26
		18-Feb-15	Torrance	USA	Explosion	0	4
	Terminal	19-Nov-84	San Juan Ixhuatepec	Mexico	BLEVE	542	4,248
		11-Dec-05	Buncefield	UK	Explosion	0	43
		23-Oct-09	Bayamón	Puerto Rico	Explosion	0	3
Power Gen	Nuclear	28-Mar-79	Three Mile Island	USA	Near Miss	0	0
		26-Apr-86	Chernobyl	Russia	Explosion	> 30	~ 7,000
		11-Mar-11	Fukushima Daiichi	Japan	Explosion	0	13
	Coal	08-Apr-99	Gannon	USA	Explosion	3	48
		10-Nov-07	Dallman	USA	Explosion	0	0
Petrochemical	Manufacture	01-Jun-74	Flixborough	UK	Explosion	28	104
		23-Oct-89	Pasadena	USA	Explosion	23	314
		21-Sep-92	Castleford	UK	Fire	5	201
		01-Feb-94	Ellesmere Port	UK	Fire	0	18
		27-Mar-98	Hahnville	USA	Asphyxiation	1	1
		13-Jun-13	Geismar	USA	BLEVE	2	167
		03-Jun-14	Moerdijk	Netherlands	Explosion	0	2
		31-Aug-17	Crosby	USA	Decomposition	0	21
Agrochemical	Manuf.	10-Jul-76	Seveso	Italy	Toxic Release	0	~ 500
		03-Dec-84	Bhopal	India	Toxic Release	2153	>200,000
		21-Sep-01	Toulouse	France	Explosion	31	2442
		15-Nov-14	La Porte	USA	Toxic Release	4	0
	Store	17-Apr-13	West	USA	Explosion	15	> 160
Pharma	Manuf.	04-Jan-92	Grimsby	UK	Runaway	0	0
		29-Jan-03	Kinston	USA	Explosion	6	38
		28-Apr-08	Cork	Ireland	Runaway	1	1
Water	Dist	23-May-84	Abbeystead	UK	Explosion	16	28
	Treat	06-Jul-88	Camelford	UK	Pollution	1	~ 400
		05-Apr-93	Milwaukee	USA	Disease	69	>403,000
Food		03-Sep-91	Hamlet	USA	Fire	25	54
		11-Apr-03	Louisville	USA	Explosion	1	0
		07-Feb-08	Port Wentworth	USA	Explosion	14	36

Rev. 10 (13-Jan-22)

P. Marsh - XBP Refining Consultants Ltd.

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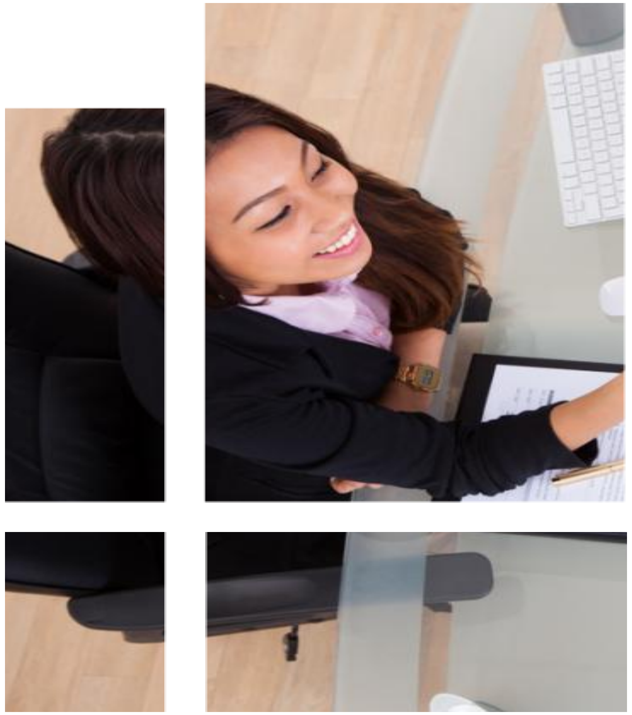
Learning From Past Incidents

- Report incidents and near misses
- Conduct root cause analysis of incidents
- Share learnings with colleagues and networks
- Accelerate replication of good practices
- Contribute to improved safety performance

Resources:

- IChemE Lessons Learned Database at:
  https://www.icheme.org/media/17707/icheme-lessons-learned-database-rev-10.pdf
- IChemE Learning Lessons from Major Incidents eBooklet
  https://www.icheme.org/media/18415/learning-lessons-from-major-incidents-v10.pdf



Steve Murphy

Hazard Study 1- early identification of hazards

Hazard Study Process

- Hazard Study is a staged process that identifies hazards and seeks to control them to an acceptable level and so ensure that hazardous process units operate safely.
- It is a key element of Process Safety Management; sometimes it is referred to as *Hazard Identification and Risk Assessment (HIRA)* or *Process Hazard Analysis (PHA)*
- Hazard Study is used throughout the high hazard industries (Oil, Gas, Fine Chemical, Pharmaceutical..)
- Clear evidence that assessing risks early in a change project maximizes safety and saves money.

- Developed by ICI in 1960’s and first published in 1970’s

- The Hazard Study Process, proven in use for the last 50 years

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Early Stage Assessment- Study 1

- Change Projects often concentrate on HAZOP studies
- These happen late in the design stage
- Often we get “nasty surprises” during HAZOP- more complexity, lead times.

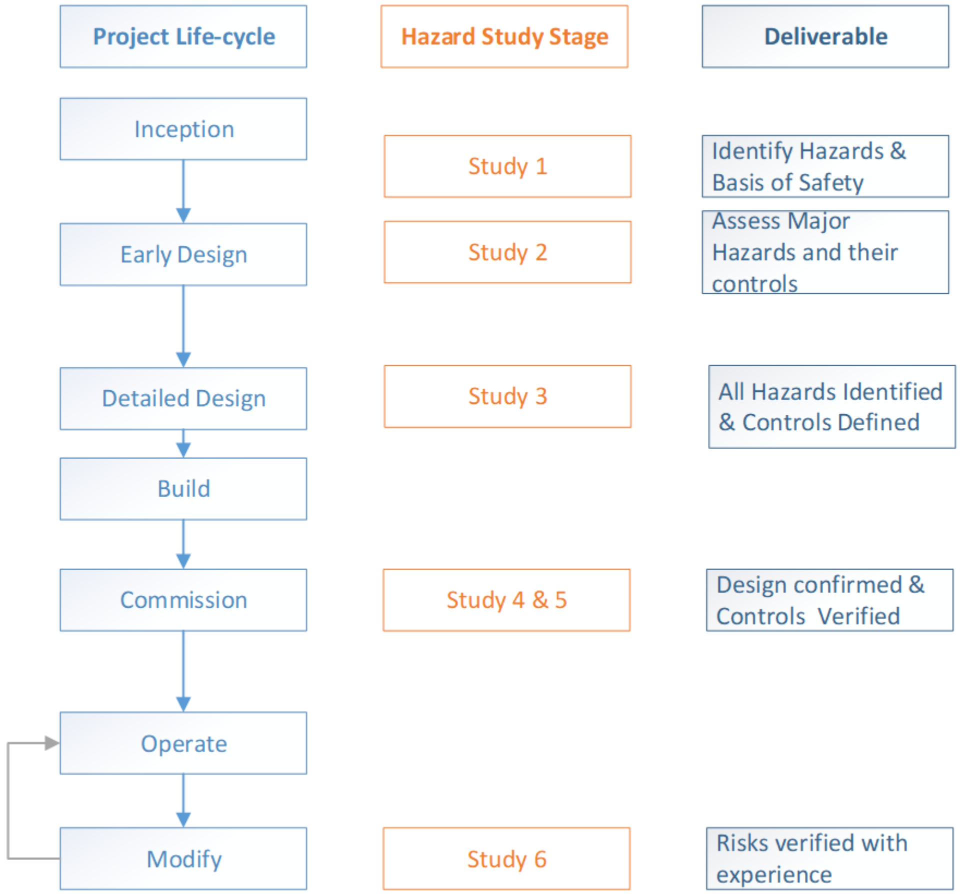
- Early identification of the key HSE Hazards is desired
  - Identify hazards and their control
  - Allows time for ordering
  - Built in cost estimating early

- Hazard Study 1 (Initial HSE Assessment)
  - Part of 6 Stage Hazard Study- HAZOP still important
  - Often over-looked
  - Advantages to doing this well

Hazard Study 1 – When?

- Change Project Lifecyle

- Study 1 early in the Inception Phase
- Typically, Terms of Reference / project team formed
- Basic Design Information
  - Where, what, when
  - Block Flow Diagram
- Chemical hazards
  - List of chemicals
  - Scale
  - Safety Data Sheets (SDS)
- Do Not have / need
  - P&ID, Reaction Hazards, detailed process



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Hazard Study 1- Structured Format

- Hazard Study 1, Allows the Project Team to define HSE / Process Safety aspects
  - Typical project team
    - Leader / facilitator
    - Project manager
    - Operations manager
    - Process Engineer
    - Other specialists

- It is broader and shallower than Study 2 or Study 3
  - Asks about Chemicals, Process, Location, Operation, Resourcing…

- Can be used to help identify other HSE assessments
  - COSHH, Environmental, Off-site impacts

Hazard Study 1- Benefits

- All team together in one room to agree scope
- Gathering of corporate memory
- Identifying hazards and any Basis of Safety
- Identifies any legal requirements
- Agrees whether any further risk assessment required.
- Creation of P&ID

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Hazard Study 1- Structured Format

Study	Outcome
HVAC System change at Laboratories	• ID Need to change filters • Plan break-ins early
Organizational changes at a Chemical site	• Listed roles and tasks affected • Prelude to more detailed Risk assessment
Change to mode of operation of Fire Water retention	Found early incompatibility of retention tanks Allowed time for treatment of concrete
New Chemical Production Plant	Assessed Fire Protection Concept Allowed resource planning for Study 2 & Study 3
Changes to an Effluent Treatment Plant	Changes to effluent pH- required controlled Neutralisation Led to full HAZOP of dosing regime

Asks Question in a Structured Format

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Hazard Study 1- Typical Sections

Introduction

- Team; roles and responsibility
- Scope; When, why, what's in and not in
- Legal requirements

Corporate Memory

- Learning from similar
- Any related incidents

Hazard Study 1- Typical Sections

Chemical Hazards

- Listing all possible chemical hazards
- List all materials. Effluents, by-products, adjuvants
- SDS Reference

Key Hazard data

- H Phrase (H 301 Very Toxic)
- Flash point, MIE other fire /explosion data
- OEL/VME
- Physical form

Hazard Study 1- Typical Sections

Process Hazards

- Define Major Hazards and their Basis of Safety
- Fires, Explosion (Dust/Vapour), Toxic Gas, Runaway Reaction, Pollution

Basis of Safety

- Basis of Safety is the high level preventative or mitigative control concept
  - E.g. Internal Fire or Explosion- Basis of Safety is control of flammable atmosphere with inerting
    - Toxic Gas release- BoS is Containment by correct choice of materials plus area alarms

Hazard Study 1- Typical Sections

Location Aspects

- Transport issues
- Building codes

People Aspects

- Who is managing the change
- Human Factors in Design

What other risk assessments are required?

- Fire
- Manual handling
- Human Health
- Area classification

Do we need any permits?

Are we following Company Standards

Summary

- It's called many things, at my Company it's the Initial HSE Assessment
- Its part of the Project Process
- Fits in with other parts of 6 Stage Hazard Study
- Identifies and documents major hazards and their basis of safety
  - High level though enough detail to assess impact on project
  - Produces a written report stating early project thinking
- Identifies other HSE aspects important to the project

- Clear benefit to using Study 1 early in Design

- Been used for over 40 years

HSE Management System Document HSE Form

75_39_01 FOR_Initial HSE Assessment_v2.0

1. Initial HSE Assessment Form

Project Title:	
Location	
Reference No.:	

Executive Summary

Team Members:
Project Manager:
Risk Assessor:
Process Owner:
Production representative:
Designer
Others, e.g. Engineering, local HSEQS, logistics, etc. as required

Report Circulation

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Questions?

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