

Was it foreseeable?

Prof. Gordon E. Andrews, School of Chemical and Process Engineering, U. Leeds

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Lecture to UKELG 21st Sept. 2016 University of Leeds

This lecture is based on the 5 day training course 'Fire and Safety Law' given by Prof. Andrews as a module in the MSc in Fire and Explosion Engineering. He has been giving this course for 25 years.

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The duties of an employer in relation to the safety of the employees has been a principle of UK common law since 1938.

The 1974 Health and Safety at Work Act set these principles in criminal law and introduced the requirement of risk analysis into safety.

I will show that risk analysis has been decided by the courts to only include risks that were foreseeable.

I will review these principles of safety law and then review hazardous operations that went badly wrong because the risk analysis had not identified obviously foreseeable events that led to disasters.

Even under COMAH with scrutiny of risk analysis by the HSE before a plant can operate, obviously foreseeable events have not been foreseen, as I will illustrate.

Why is it that foreseeable problems are not foreseen when risk analysis is undertaken, even when the consequence are severe such as at Buncefield, Texas City, Flixborough and Deepwater Horizon? The answer seems to be bad management and bad safety enforcement, this is particularly so in USA incidents.

It was not until **1938** in **Wilson & Clyde Coal Co. Ltd. V. English (1938 AC 557)** that the House of Lords identified, in general terms, the duties of an employer in common law. But the principles established were that all employers are required to provide and maintain:

a safe place of work

a competent staff of men and women

a safe system of work

safe plant and appliances

Also employers were made liable for accidents causing injury to their employees as a consequence of the negligence of another of their employees, provided that the act of negligence arose out of and in the course of employment. All this is now required by Statutory Law as well (see HSAWA 1974 in later section).

Where the duty of care relates to a specialised area, then the duty of care expected is one which would be expected from someone with those skills in the same profession, as was decided in Bolam v. Friern Hospital Management Committee (1957).

Where industrial practices are concerned, one must look to standards which are deemed reasonable by the industry concerned.

In the case of Dominion Natural Gas CO. v. Collins & Perkins (1909), it would appear that **where hazardous substances are involved in the industrial practice then the standards of care will be judged more highly.**

The Health and Safety at Work Act 1974 -3

1. (1) The provisions shall have effect with a view to –
 - (a) securing the health, safety and welfare of persons at work
 - (b) protecting persons other than persons at work against ***risk*** to health or safety arising out of or in connection with the activities of persons at work.
This means the public and contractors.
This is expanded on in s.3 of the Act
 - (c) **controlling the keeping and use of explosive or highly flammable or otherwise dangerous substances** and generally preventing the unlawful acquisition, possession and use of such substances

The Health and Safety at Work Act 1974 -6

1. (3) For the purposes of this Part, risks arising out of or in connection with the activities of persons at work shall be treated as including **risks attributable to the manner of conducting an undertaking, the plant or substances** used for the purposes of an undertaking, and the condition of premises so used or any part of them.

At Deepwater Horizon BP contractors took unacceptable risks in the manner of conducting an undertaking (drilling a deep well) so as to save about \$2.2M in immediate costs with future costs reduced, as we will see later.

The Health and Safety at Work Act 1974 -7

Sec. 2 General duties on all employers to their employees, which are all conditioned by the term **'so far as is reasonably practicable'**.

2 (1) To ensure the health and safety and welfare at work of all his employees

2 (2) (a) **To ensure the provision and maintenance of safe plant and systems of work that are safe and without risk to health.**

(b) arrangement for ensuring safety and absence of risk to health in connection with the use, handling, **storage** and transport of articles and **substances**.

(c) To provide such information, instruction, training and supervision as is necessary to ensure the health and safety at work of employees.

(d) To maintain **a safe place of work without risk to health** and to provide and maintain safe, without risk to health, access to and egress from that place of work.

(e) To provide and maintain a working environment for employees that is safe and without risk to health.

2 (3) To provide and maintain a written statement of safety, detailing the safety policy of that company, arrangements for carrying out that policy, and to bring the statement to the notice of all of his employees.

Edwards v. National Coal Board 1949

Lord Asquith went on to generalise his judgement so that it applied to all cases that used the term **'reasonably practicable'**.

6. Employers must make a computation where the amount of risk is placed on one side of the scale and is then balanced against the sacrifices in money, time or trouble incurred by taking measures to avoid the risk.

7. Where an employer can show that there is a gross disproportion between both sides of the scale and that the risk is insignificant in proportion to the cost, then it has been shown that it is not reasonably practical to take the safety measures.

*Note that risk analysis is essential in any determination of what is 'reasonably practicable'. Also note that **this case shows that doubling the expenditure on shoring up mine roads is considered reasonable. This means in future cases that disproportionate costs would have to be much greater than doubling current safety expenditure.***

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Grovehurst Energy Ltd v. Strawson 1990.

F.P. Chambers, Health and Safety at Work, 1995.

G. was a generator and supplier of electric power and steam to paper manufacturers. Its contract with the manufacturers provided that if it failed to supply such power, then the loss to them was £86,000 per day. G was reported for using equipment which was not suitable for further use. A prohibition notice was served.

G appealed against the notice on the ground that extra safety precautions were being taken to prevent injury in the event of a failure of the equipment.

The industrial tribunal ruled that the appeal should be dismissed, for the following reasons:

- 1. If the equipment failed, there was a very substantial risk of injury**
- 2. The potential consequences of a catastrophic failure were very serious.**
- 3. Possible loss of profit, and an undertaking to provide extra safety precautions, were not in themselves sufficient grounds for the suspension of a prohibition notice.**

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Doughty v. Turner Manufacturing Co. Ltd 1964

A fellow worker of Doughty let an asbestos cement cover fall into a cauldron of molten metal which resulted in an explosion causing an injury to Doughty. **No similar incidents of this kind had occurred previously and it was not known that explosions were caused by asbestos cement mixing with molten metal.** Although the action of the defendant's servant was the direct cause of the accident, it could not be shown that the defendant had failed to exercise reasonable foresight and hence he was not liable. *Thus it is not reasonably practicable to foresee a risk that was not known.*

You are required to keep up to date with knowledge.

Most of the explosion case studies in this presentation did not involve a lack of knowledge and were thus all foreseeable incidents that should have been prevented.

Was it foreseeable?

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Leeds University – Prof. Andrews Explosion Incident

In the 1980s my explosion research PhD carried out a test on a stoichiometric hydrogen-air explosion at 3 bar initial pressure, where the peak pressure was expected to be 21bar, which was within the design pressure of the vessel.

The mixture underwent a spherical flame detonation and an observation window blew out and the pressure wave from this blew out the laboratory window. No one was injured.

The spherical flame detonation of hydrogen at 3 bar was not known at the time **so the accident was not foreseeable.**

However, it could be argued that as we were not using the window at the time it should have been blanked off and I have never had a window in an explosion vessel since.

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HM Inspector of Factories v. Austin Rover Group Ltd 1989

Prosecution under HSWA s4(2) – 1

F.P Chambers, Health and Safety at work, 1995

At Austin Rover's Cowley works were a number of paint spray booths. The floor of each sloped down towards pipes which led into the sump. Water, excess paint and solvents from the spraying operation ran into the sump via the pipe. In the wall of each booth was a pipe which supplied highly flammable thinners during painting. The booths had a ventilation system which also changed the air in the sump. **The sump had no direct ventilation or lighting.**

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HMIF v. Austin Rover Group Ltd. 1989 – 2

Both the booth and the sump were cleaned under contract by W as a contractor. W was required under the terms of the contract:

1. To provide their own thinners (solvents)
2. Not to use Austin Rover's thinners
3. Not to enter the sump while cleaning operations were being carried out in the booth above *[Why? Clearly AR knew that flammable vapours, which are heavier than air and would flow down into the sump, were present and a spark from above caused by someone working above could ignite them and cause an explosion in the sump which had no direct ventilation and hence would fill with a flammable mixture – this is what happened and AR clearly knew that this was a possibility, otherwise why this instruction. This was clearly an unsafe operation and they could have been prosecuted under 2(2)(a)&(b) as well as the Factories Act Sec. 30 and 31 (see earlier. Also s3 was possibly a more relevant clause as the contractors were 'others' and they had been put at risk by AR)*

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HMIF v. Austin Rover Group Ltd. 1989 – 3

4. Only to use approved safety lamps

Why? Because AR knew that there was an explosion risk and they did not eliminate it. An approved lamp is assumed to mean an explosion proof lamp certified for use in a flammable atmosphere.

If there is an explosion risk, which is the reason for only using approved safety lamps, then why were all sources of ignition not eliminated. Even if the contractors had used approved safety lamps they could have caused an electrostatic spark through the rubbing actions involved in cleaning. The wearing of electrostatic free clothing and boots and the dangers of electrostatic ignition should also have been a condition of the contract.

Also, sparks could have been caused by friction including nails on boots or any of the tools used for cleaning.

The required actions in risk analysis and the methods to eliminate the risks are now detailed in DSEAR (Dangerous Substance and Explosive Atmospheres Regulations 2003 – see later in Part 2). At the time these risks had to be eliminated under the Factories Act s. 31.

Sec. 4 Imposes a **duty on persons in control of premises to persons other than their employees.** *Note that this clause is not in EC law*

- (1) This section has effect for imposing on persons duties in relation to those who-
 - (a) are not their employees; but
 - (b) use non-domestic premises made available to them as a place of work or as a place where they may use plant or substances **provided for their use** there.

If you don't provide and plant or substances for contractors then this case says you are not liable – EU law changed this in 1992. This is what Austin Rover were exploiting.

and applies to premises so made available and other non-domestic premises used in connection with them.

- (2) It shall be the duty of each person who has, to any extent, control of premises to take such measures as it is reasonable for a person in this position to take to ensure, so far as is practicable, that the premisesare safe and without risk to health.

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HMIF v. Austin Rover Group Ltd. 1989 – 4

E an employee of W, went into the sump while a fellow-employee was working in the booth above. He was killed by a flash fire which broke out in the sump. It emerged that the fellow-employee had used Austin Rover's thinners and that E had not used an approved safety lamp.

AR were prosecuted for a breach of s4(2). **Specifically it was alleged that the company had not ensured that thinners did not enter the sump, nor that there was sufficient ventilation in the sump (contravention of s.30 of the Factories Act). The magistrates convicted the company and imposed a £2,000 fine [Wow – I bet that hurt AR!]**

It was found that isolation of AR thinners could have been effected by capping off a pipe or closing a valve. Proper ventilation could easily have been provided and both precautions were reasonably practicable and hence 4(2) could easily have been complied with.

Most of us would probably agree with this judgement. Why did AR appeal after such a paltry fine – probably to protect their reputation – or that of their safety manager (see later).

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HMIF v. Austin Rover Group Ltd. 1989 – 5

AR appealed and the Divisional Court allowed the appeal, ruling that the magistrates should, have reached findings as to **whether the accident had been reasonably foreseeable**. In the view of Lord Justice Woolf, having regard to the terms of s4(2), **there was no duty to take precautions against risks that were not reasonably foreseeable**.

HMIF appealed to the House of Lords, who dismissed the appeal:

1. The divisional court had been correct.
2. **It had not been established as a fact that the respondents could reasonably have foreseen the misuse of their premises which were the essential cause of the accident.**
3. The reasonableness of the measures which owners and occupiers were required to take, in compliance with s(4), when premises were made available for another, must be determined in the light of knowledge of the anticipated use, and in the light of the extent of his control and knowledge of the actual use.

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HMIF v. Austin Rover Group Ltd. 1989 – 6

4. **If premises were not a reasonably foreseeable cause of danger** to anyone acting in a way in which a person might **reasonably** be expected to act in the circumstances which might **reasonably** have been expected to occur during the carrying out of the work, then it would not be **reasonable** to require an individual to take further measures against unknown and unexpected risks.

[This is nonsense in this case – it was clear that AR knew that there was an explosion risk and they did not eliminate the risks, thus putting their own workers and the contractors at risk. Unfortunately the Judge was ignorant about explosion hazards and the barrister for HMIF did not point this hazard out!].

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HMIF v. Austin Rover Group Ltd. 1989 – 7

5. The word ‘reasonable’ was relevant to the person in control of the premises, and not the measures.

[The regulation 4(2) states that ‘it SHALL be the duty of each person who has control of the plant (AR) to take such measures as are reasonable for a person in his position to take to ensure, sfaipr, that the premises and plant is safe and without risk to health’. Clearly, if the reasonableness applies to the actions of the person then the ‘measures to ensure the plant is safe’ is an absolute duty with no conditions i.e. sfaipr does not apply to the measures only to the action of the person (AR).]

The question to be asked in such cases was **whether it was reasonable for a person in the position of the accused to take measures to ensure safety and the absence of risk to health**, not whether there were measures which themselves were reasonable which could be taken.

[Was it reasonable for AR to have taken measures in this case – of course it was – their instructions to W clearly shows that AR knew there was an explosion risk – this Judgement is perverse].

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HMIF v. Austin Rover Group Ltd. 1989 – 8

6. In the present case, there had been several events leading up to the fatal accident, which should not have happened had those concerned been acting according to instructions. **In the absence of any finding that the respondent should have foreseen any of those events, it could not be said that it was reasonable for them to have taken measures to make their premises safe against unanticipated misuse.**

[These Judges need to get out into the real world – anyone with any experience of Contractors knows that the most likely thing that they will do is not to follow instructions if the job can be done quicker and cheaper by ignoring them. Indeed most experienced industrialist would say that it was negligent to assume that a contractor would obey instructions!]

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HMIF v. Austin Rover Group Ltd. 1989 – 9

Following this Judgement the Safety Manager of AR presented a paper 'In search of safety excellence – the Rover experience' at the IMech E Conference 'Successful Management for Safety', Oct. 12/13 1993.

In this there is the arrogant statement

'Rover was successful in defending its safety approach to contractorisation when prosecuted by the factory inspectorate!'

A man died in this incident, which he did not mention in his presentation, that was easily preventable, if AR had had a safe system of work. If one of their own employees had died they would have been guilty under s2(2)(a)&(d) – they essentially got off on a technicality.

MAILER v. Austin Rover Group Ltd. 1989 (**Common law** case)

The main judgement in the House of Lords held:

That once it was proved in a prosecution under s4(2) that premises, which had been made available by a controller, were unsafe and constituted a risk to health, the controller has to remove the risk unless it was not reasonably practicable for him to take these measures as the cost was unreasonable.

However, **if the premises were not a reasonably foreseeable cause of danger to persons using the premises in a manner or in circumstances which might reasonably be expected to occur, it was not reasonable to require any further measures to be taken to guard against unknown and unexpected events which might imperil safety.**

Since it was not reasonable for the respondents to take measures to make the spray painting booth and sump safe against the unanticipated misuse of those premises by the contractor's employees the magistrates had been wrong to convict the respondents.

But the premises made available by the controller were unsafe as his instructions showed that he knew there was an explosion risk which he chose not to tell the contractors about. There was also no evidence that the contractors would be expected to know about the explosion risk.

MAILER v. Austin Rover Group Ltd. 1989

The reasoning of their Lordships was interesting. They took the view that the starting point was that the premises should be absolutely safe so that if they proved to be unsafe [*as they obviously were – they blew up and AR knew this could happen*], regardless of the way in which they had been used, the burden shifted to the controller, who **might then escape liability by establishing that it was not foreseeable that the premises would be used in the manner in which they have been used** and/or it was not incumbent on him to have done more to make the premises safe.

Barrett and Howells, Occupational Health and Safety Law, 3rd Ed. 1997

In deciding the extent of the duty the court had to bear in mind the double qualification on the controller's duty: s4(2) required the controller to do only what was reasonable for someone in his position to do to ensure so far as is reasonably practical that the premises were safe.

Thus the term 'so far as is reasonably practical' includes the premise that reasonable means that what happened must have been foreseeable.

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The Framework Directive 89/391/EEC - 15

Section 2 Article 10 Worker Information

1. The employer SHALL take appropriate measures so that workers receive all the necessary information concerning:
 - (a) the safety and health risks and protective and preventive measures and activities
 - (b) the measures taken pursuant to Article 8(2)

[HSWA s2(3)]

2. **The employer SHALL take appropriate measure so the employees of workers from outside engaged in work in his undertaking (*i.e. contractors*) receive adequate information as in (1) above.**

[HSWA s3]

Thus the circumstances of the Austin Rover case would be illegal under this legislation.

The Framework Directive 89/391/EEC

Article 7 Protection and prevention services – 1

1. Without prejudice to the obligations referred to in Articles 5 and 6, the **employer shall designate one or more workers to carry out activities related to the protection and prevention of occupational risks** for the undertaking and /or establishment.

Section 2 Article 7 – 2

3. If such protective and prevention measures cannot be organised for **lack of competent personnel** in the undertaking, **the employer SHALL enlist competent external services** or persons (*consultants*).
5. The workers designated must have the necessary capabilities and the external services consulted must have the necessary aptitudes and professional means.

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The Framework Directive 89/391/EEC

Competent Person – 4

Framework Directive Article 7(5)

In all cases:

- the workers designated must have the **necessary capabilities** and the **necessary means**,
- the external services or persons consulted must have the **necessary aptitudes** and the **necessary personnel and professional means**, and
- the workers designated and the external services or persons consulted must be sufficient in number,

to deal with the organisation or protective and preventive measures

None of this is particularly precise and no qualifications is mentioned nor is experience directly mentioned.

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The Framework Directive 89/391/EEC

Competent Person – 5

In the British 'Management of health and safety at work Regulations 1999' which implement the Framework Directive a competent person is defined as:

Regulation 7(5) states:

A person shall be regarded as competent for the purposes of 7(1) and 7(8) where he has **sufficient training and experience or knowledge and other qualities properly to undertake the measures** referred to in that paragraph himself.

Does knowledge imply qualification? Why are the regulators so resistant to asking for qualified people to undertake risk assessments? The EC definition uses the word 'necessary capabilities and means' these do not appear in the British definition. Neither is really satisfactory.

Focus, FIA, Issue 20 2011 p.9 Named and Shamed + Fire Safety Professional Autumn 2011 p.5

Hotel Owner AND Fire Risk Assessor Jailed

A hotel owner and fire risk assessor were each jailed for eight months + £15K costs for 15 breaches of the RRO Fire Safety – this is believed to be the first instance of a Fire Risk Assessor being prosecuted.

David Lui was the operator of the Market Inn and the Dial Hotel in Mansfield, Nottinghamshire and the fire risk assessor was John O'Rourke (Mansfield Fire Protection Services) who had £5,862 costs to pay. They both admitted to serious contraventions of the RRO Fire Safety. John O'Rourke admitted to two offences in providing an inadequate fire risk assessment. He appealed against the decision but this was dismissed by the Court of Appeal on 1. Sept 2011.

Routine inspections by the Nottinghamshire FRS revealed that the fire precautions were inadequate at both hotels. These deficiencies had not been pointed out in the fire risk assessment by John O'Rourke. The occupants would be seriously at risk in the event of a fire.

Fire doors were locked or missing, emergency exit routes were obstructed and appropriate fire fighting equipment, detectors and fire alarms were not provided.

Prohibition notices were issued until improvements were made.

It is the responsible persons duty to see that any fire risk assessor he employs is competent. If he is not competent the responsible person as well as the incompetent assessor will be guilty under the RRO.

Problem is that there is no certification scheme for approved fire risk assessors competency, in the same way there is for electrical work or work on gas supplies.

Currently the courts are deciding on the competency of fire risk assessors after fire inspections by the FRS or after fires have occurred.

The British Regulations are more conditional than the EC Directives, which do not condition every general duty with the phrase ‘so far as is reasonably practicable’.

For example the Directive says in Article 6(3)a

The employer SHALL evaluate the risks to the H&S of workers.....

The British Regulation 3 says:

Every employer shall make a ‘suitable and sufficient’ assessment of the risk to the H&S his employees.....

The only conditional words in the Directive are ‘necessary’ and ‘adequate’, as in Article 7(5) ‘the workers designated must have the ‘necessary’ capabilities and in Article 12 (1) the employer shall ensure that each worker receives ‘adequate’ safety and health training. What is necessary or adequate has to be defined by regulations or ACOPs in particular circumstances.

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‘Suitable and Sufficient’ risk assessment - 1

This term is defined in the ACOP on p.6 para 13.

It acknowledges that the term is NOT defined in the Regulations.

‘In practice it means the risk assessment should do:

- (a) Identify the risks, the level of detail is proportionate to the risk. Ignore insignificant and routine risks.**
 - (i) Small businesses – no complexity in the risk analysis**
 - (ii) Intermediate cases – more detailed analysis, may require specialist advisors**
 - (iii) Large and hazardous sites – sophisticated risk assessment, likely to be COMAH site (see later)**
 - (iv) Risk assessment must also consider all those who might be affected by the undertaking e.g. public**

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‘Suitable and Sufficient’ risk assessment – 2

- (b) Employers are expected to take ‘reasonable’ steps to help themselves identify risks e.g. by looking at appropriate sources of information. They should use relevant industry good practice. *The risk assessment should include only what an employer could REASONABLY be expected to know; they would not be expected to anticipate risks that were not foreseeable* [this was established in common law cases e.g. Cambridge Water 1994, also the Rover case 1988 that is discussed later].
- (c) The risk assessment should be ‘appropriate’ to the nature of the work and should identify the period of time for which it is likely to remain valid.

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‘Suitable and Sufficient’ risk assessment

The word ‘reasonable’ appears in numerous places in the ACOP and it is likely that the standard of H&S required under these Regulations is little different from that under the ‘reasonably practicable’ term in the HSWA.

However, the legal definition of this term allows the risk to be balanced against the cost. A high expenditure on risk reduction is not required unless the risk consequences are high.

The ACOP does not say this directly, but in its detail it is clear that there is no real change. More expenditure will be required the higher the consequences of the risk are, which has applied since 1949.

Much of the definition of ‘suitable and sufficient’ is meaningless or very subjective, without detailed guidance for a range of industries and the HSE does this through a series of safety guidance books for industries such as printing, paper manufacture etc.

COMAH – Top Tier Safety Reports must demonstrate that:

i) A MAPP has been prepared

ii) major accident hazards have been identified and that the necessary measures to prevent them and limit their consequences have been taken.

Why was tank overfilling at Buncefield not foreseen as a major hazard and necessary measures put in place to prevent it – why was overfilling not foreseen in the risk analysis?

iii) the design, construction, operation and maintenance of the establishment are adequate

iv) on-site emergency plans have been prepared

v) information has been supplied to the local authority for the purposes of their off-site plan and land use planning decisions

vi) risks to the environment have been adequately covered.

This environment risk was inadequately covered at Buncefield as overfilling was not a foreseen event!

The safety report must be updated every 5 years

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Paul Denham, Law, p. 256, 1994. H&S.

Recklessness in criminal law means that the defendant deliberately pursues a course of action which probably (rather than possibly) will create serious and harmful consequences; the defendants may or may not be aware of the consequences of his action, or possible omission, the point being that he has pressed on regardless – he could not care less, he is recklessly careless.

Negligence means, however, that he was careless in an accidental sense, yet the consequences are still sufficiently grave, if not as serious or harmful as the consequences of recklessness, to impose liability. The defendant in negligence does little more than his incompetent best, but the chances are he would have stopped what he was doing if he fully appreciated the consequences of his action or omission.

How can 'competent' employees not know the consequence of their actions? Recklessness is at the heart of most of the major hazards in recent years.

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7. R. v. Caldwell 1982 In Eliot and Woods – Cases and Materials in Criminal Law 7th Ed. 1997 p.118 – 127.

Merrick [1996] cont.

The court of appeal judgement included the following:

“There is a clear distinction to be drawn between the avoiding of a risk and the taking of steps to remedy a risk which has already been created. If an accused person is successfully to contend that the taking of certain steps has prevented him from falling within the definition of recklessness then those steps must be ones directed toward preventing the risk at all, rather than remedying it once it has arisen.”

The court of appeal did not address three important issues

- (1) Whether the risk taken by D was a justified one in which case the taking of that risk may have been reasonable in the circumstances where the cable was under D’s supervision and action to render it safe was immediate. In many cases not all risks can be foreseen.**
- (2) The question of lawful excuse**
- (3) Whether the risk was not obvious (by reason of age, lack of experience or lack of understanding). See Elliot v.C 1983 14 year old remedial girl burnt a shed down – obvious risk refers to a normal adult person, appeal allowed against an initial conviction.**

Rylands v. Fletcher 1868 (LR 3 HL 330) House of Lords.

Lord Cranworth in supporting this judgement makes the key summary of the new law:

‘If a person brings, or accumulates, on his land anything which, if it should escape, may cause damage to his neighbour, he does so at his peril. If it does escape, and cause damage, he is responsible, however careful he may have been, and whatever precautions he may have taken to prevent the damage.’

R. Kinder, Casebook on Torts, 1999, Blackstone Press p.386

The key point in this new law is that there has to be no negligence in the storage of the non-natural material. If it escapes and causes damage then owner of the land or non-natural material are liable and this is a strict liability.

This was a powerful new principle in law and of major relevance to pollution i.e. the escape of toxic material. Unfortunately, there has been a series of legal cases that undermine the power of the original decision.

An important part of Lord Goff's ruling in the House of Lords on the CW v ECL 1994 case was the statement:

'I feel bound to say that the *storage of substantial quantities of chemicals on industrial premises should be regarded as an almost classic case of non-natural use; and I find it very difficult to think that it should be thought objectionable to impose strict liability for damage caused in the event of their escape.*

This means that negligence does not have to be proven if you are made ill or your crops damaged by chemicals released as pollutants or discharged into rivers. Also LPG storage if say a BLEVE resulted and your property was set on fire, then negligence would not have to be proven.

Remember that statutory law fines the polluter it does not compensate those who are made ill. This important decision in common law makes it easier to get compensation when chemicals leak from factories.

Milton Keynes fire 11.12.05 – blast damage outside the Perimeter and hence the company would be liable for all the damage under RvF.

The Rylands v. Fletcher rule was argued to apply in the water pollution case of Cambridge Water (CW) v. Eastern Counties Leather (ECL) 1994.

The key points in the case were that in ECL over a long period of time (1950 to 1976) had spilt perchloroethene (PCE) during filling of chemical plant. This seeped through rocks and contaminated the water supply of CW, making the borehole useless and a new borehole had to be drilled at a cost of £1M.

The judgement did decide that there was a non-natural use of the land, but it decided that **ECL were not liable as the contaminated of the borehole was not foreseeable as PCE was not listed as a toxic substance at the time of the spillages.**

Hughes et al., Environmental Law 4th Ed. 2002, p. 134

Lord Goff also re-emphasised the strict liability nature of Rylands v. Fletcher:

‘knowledge, or at least foreseeability of the risk, is a prerequisite of the recovery of damages under the principle (Rylands v. Fletcher); but the principle is one of strict liability in the sense that the defendant may be held liable notwithstanding that he has exercised all reasonable care and skill to prevent the escape from occurring’

Negligence

Negligence is the breach of a legal duty to take care which results in damage caused by the defendant to the plaintiff.

There are four constituents of negligence all of which must be proved to get a conviction:

- 1. The defendant must owe a duty of care to the plaintiff**
- 2. That duty of care must be recognised by the law.**
- 3. There must be a breach of that duty**
- 4. The plaintiff must suffer damage as a result of that breach.**

This is the weakness of common law – the damage must occur before action can be taken. With statutory law the conditions that lead to breaches of safety can be regulated before harm occurs.

In safety cases for employees 1 and 2 are established.

Donoghue v. Stevenson 1932

Lord Atkin went on to generalise his judgement and it is this that is quoted in all negligence cases.

‘The rule that you are to love your neighbour becomes in law, you must not injure your neighbour; and the lawyer’s question, Who is my neighbour? receives a restricted reply.’

‘You must take reasonable care to avoid acts or omissions which you can reasonably foresee would be likely to injure your neighbour (this is the ‘others’ in health and safety law).

Who then, in law, is my neighbour? The answer seems to be – persons who are so closely and directly affected by my act that I ought to have them in my contemplation as being so affected when I am directing my mind to the acts or omissions which are called in question’

(Duncan Holmes, Torts 4th Ed., 1997 Butterworths (Australia).

J. Conaghan and W. Mansell, *The Wrongs of Tort*, Pluto Press 1993 p.14.

The phrase ‘reasonably foresee’ and ‘ought reasonably’ do not limit necessary relationships with clarity. What is considered reasonably foreseeable by one Judge might be considered quite unforeseeable to another.

If reasonable foreseeability could be ascertained objectively, it would require a very peculiar piece of reasoning, since it requires a Judge to decide, in retrospect, what she could reasonably have expected a defendant to have reasonably foreseen would be the result of her contemplated act upon people who might be affected, had the defendant foreseen the accident itself – which in most cases she almost certainly did not or a different course of action would probably have been pursued!

Remoteness of Damage

There is an old traditional nursery rhyme that runs as follows:

For want of a nail, the shoe was lost,
For want of a shoe, the horse was lost,
For want of a horse, the King was lost,
For want of the King, the battle was lost,
For want of the battle, the war was lost.

Is the blacksmith who failed to place the nail in the horse's shoe responsible for the loss of the war?

The is a question of remoteness.

The Wrongs of Tort, J. Conaghan and W. Mansell, 1993, Pluto Press, p.49.

Was it foreseeable?

Prof. Gordon E. Andrews, School of Chemical and Process Engineering, U. Leeds

Flixborough can also be summarised under remoteness of damage.

1. For the want of a stirrer gland, cyclohexane leaked.
2. The leak was condensed with plant water instead of the gland being replaced.
3. The water caused stress corrosion cracking of a hexadecane distillation vessel.
4. The stress corrosion cracking led to this distillation column being taken out of the line of 6 distillation columns.
5. A temporary pipe was fitted, inadequately designed.
6. The pipe failed and there was a massive explosion.

The failure to replace a gland did lead to the massive explosion. The management system that failed to replace the stirrer gland was at fault.

This well known **explosion was clearly foreseeable.**

Trevor Kletz 'Learning from Accidents' 2nd Edition 1994 p.74.

Remoteness of Damage

Lord Atkin's judgement in the *Donoghue and Stevenson* case had the phrase 'directly affected by my act'. An action of negligence will therefore fail if the damage the plaintiff has suffered is too remote a consequence of the defendant's conduct. Two cases dominate interpretation of this:

1. *Re Polemis and Furness Withy & Co.* 1921

The charterers of a ship loaded benzene on board the ship, which leaked into the hold of the ship filling it with benzene vapour. **An employee of the charterers negligently dropped a wooden plank into the hold, which caused a spark which ignited the benzene-air mixture and blew up the ship. The court of appeal ruled that this action was not too remote.**

2. Overseas Tankship (UK) Ltd. V. Morts Dock & Eng. Co. Ltd. 1961 (The Wagon Mound No.1) and 1967 (The Wagon Mound No. 2).

These two cases relate to the same incident.

The SS Wagon Mound Captain carelessly allowed a large quantity of bunkering oil to spill into Sydney Harbour. The oil spread over the water to Sheerlegs Wharf, where welding operations were in progress. This was ceased after the oil was spotted and advice taken from an oil company. It was deemed to be safe to continue welding, but a spark landed on some cotton waste floating on the oil and this was set on fire and the oil then ignited and caused fire damage to the wharf. In this case it was **deemed that the fire was not foreseeable and the welders could not reasonably be expected to know that this would occur – foreseeability.**

2. Overseas Tankship (UK) Ltd. V. Morts Dock & Eng. Co. Ltd. 1961 (The Wagon Mound No.1) and 1967 v. The Millers Steamship Co. (The Wagon Mound No. 2) cont.

In the Wagon Mound No.2 case in the same incident two ships owned by the Millers Steamship Co. and moored at the Wharf were damaged by the fire. The company sued Overseas Tankship for damages and in this case the House of Lords decided that negligence had occurred as the Chief Engineer of the ship had allowed the oil to spill for a long period and had the education and experience to know that oil on water was a fire hazard. This the fire that resulted was a foreseeable and direct consequence of his negligent action.

In the No. 1 case it was the welder who, although igniting the fire, was not considered to have the technical knowledge to foresee the consequences of his action – no liability.

My experience

Gas Turbine atmospheric pressure combustion rig.

Three combustion rigs connected to a common exhaust line. An explosion had occurred due to failure of a flame to ignite and continuing to try for too long. The explosion blew out an observation window in the third combustion rig that was not in use – the first combustion rig was in use. Isolation of rigs not in use, but connected to the exhaust system, was then adopted.

However, 15 years later there was a fire on the same No. 1 combustion rig that ignited the fire wall and doorway.

This resulted from a failure to remove the isolation valve after a previous test on another rig, followed by a month or two inactivity on the test rig.

Thus the exhaust had nowhere to go but out through gaps in the rig which ignited the wooden door frame close by.

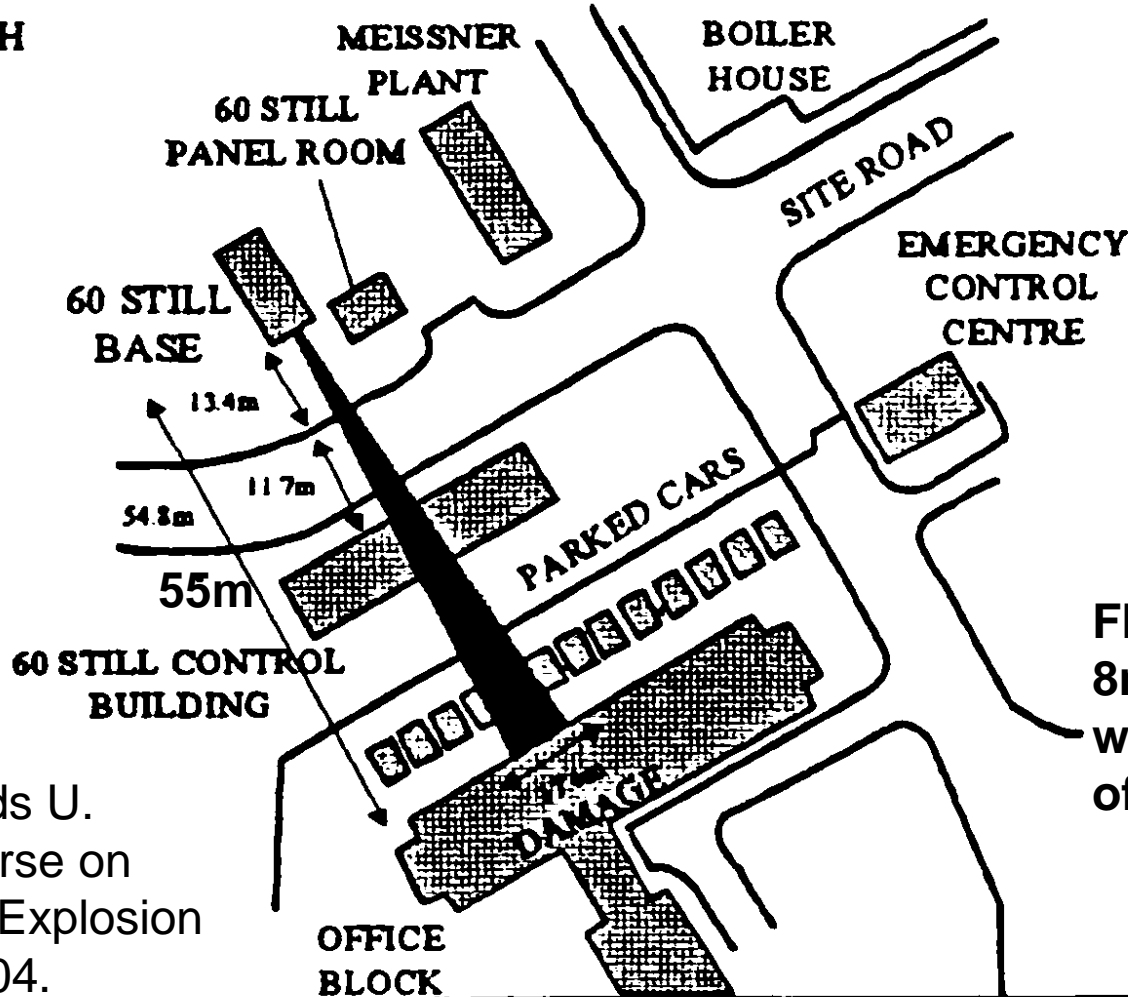
In both cases the accident was foreseeable – fortunately no one was injured. The first case was a failure to follow procedures or permit to work and the second was human error. A series of tick box operating procedures was introduced after this to avoid human error.

From Ken Patterson, Safety Manager

Path of flame

Hickson and Welch
Castleford Sept. 1992.

NORTH



Flame jet was 8m diameter when it hit the office block.

The Leeds U.
CPD course on
Fire and Explosion
Sept. 2004.

The Process

It clearly had experience of nitro
Toluenes and knew all the
precautions. It could not claim
that what happened was not
foreseeable.

- H&W was the 2nd largest manufacturer of nitrotoluenes - capacity 30,000 tonnes per year
- Continuous nitration plant
- Different materials separated by repeated distillation & crystallization

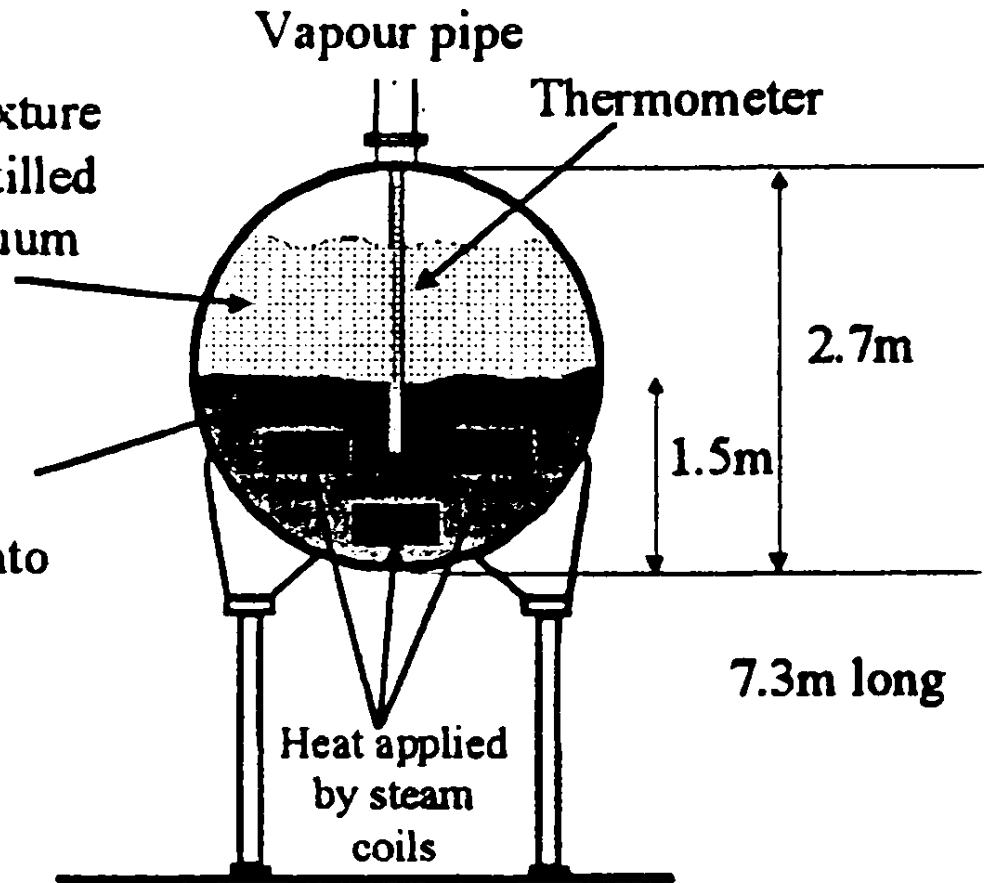
The site had been used for chemicals
Manufacture since 1915 –
explosives manufacturer.



60 Stillbase end view

Vessel filled with mixture of nitrotoluenes - distilled by boiling under vacuum

Residual liquid after distillation pumped into storage for disposal



Essentially the incident was a thermal runaway and was caused by the material being in contact with the wall of the steam heaters and hence heated close to the steam temperature, which was above the autoignition temperature of the nitrotoluene byproduct residue. The significant error was to use a thermocouple that was not in the residue and also not to realise that the steam pipes were in direct contact with the residue and that this would locally heat the residue much higher than any control temperature would indicate.

However, the problem really lay with the management, as inadequate control was exercised over how the residue was to be safely removed.

The company recognised that the incident was 'due to cumulative management failures and omissions which represented corporate failure'.

This incident was clearly foreseeable and should have been in their risk analysis for the cleaning operation of the still and the permit to work for the operation.

BP Refinery Explosion and Fire Texas City 23.3.05

15 Dead 170 injured



Oil plant explosion leaves at least 14 people dead

A BP Group Executive was assigned to lead investigation on behalf of BP Products North America. An interim BP report of the findings was issued on 12th May 2005. The report issued to OSHA and CSB

CRITICAL FACTORS IDENTIFIED

This was an 'overfilling' event

- ❑ LOSS OF CONTAINMENT – **Events**; A Blowdown Drum/Stack vented to atmosphere causing a vapour cloud ignited by “unknown source”
- ❑ START UP PROCEDURE - **Failure** to follow the startup procedure contributed to the loss of process control.
- ❑ SKILLS & KNOWLEDGE – **Lack**; Key individuals (management and operators) displayed **lack of applied skills and knowledge**; a lack of supervisory presence and oversight during the startup.
- ❑ SITING – **Location**; Personnel working elsewhere in the refinery were too close to the hazard (temporary trailers). No alert & evacuation.
- ❑ EQUIPMENT – **Design**; Blowdown stacks potentially hazardous for this type of service - the industry has moved to closed relief systems (e.g., flare). Earlier opportunities to tie the Splitter relief lines into a flare system were not taken.

The Occupational Safety and Health Administration (OSHA) and the Chemical Board are conducting separate investigations. OSHA's probe is expected to take six months, while the Chemical Board will probably take 12 months to complete its' findings.

Of interest are the following incidents which occurred at the same plant.

- ❑ The day prior to the explosion, a furnace valve caught fire.**
- ❑ March 2004 a similar explosion on the same plant had occurred, requiring evacuation of the entire facility. Afterwards BP were fined \$US63,000 for 14 safety violations including problems with its Emergency Shutdown System and Employee Training.**
- ❑ In 2002 at the same plant 2 maintenance employees were killed when scalding hot water (260°C) was released from a pump seal – only a check valve was used as isolation for the pump.**
- ❑ The Alaska Oil and Gas Conservation Commission fined BP \$US700,000 for a well head explosion in 2002 in Prudhoe Bay.**

A record of repeated failures in a company is a sign of poor safety management and inadequate risk analysis or a failure to foresee what should have been foreseen could and did go wrong.

Failure to Learn – The BP Texas City Refinery

Andrew Hopkins 2010 CCH – Wolters Kluwer business.

BPs economic success under Lord Browne the CEO since 1995, when it grew by a factor of 5 to become the second largest oil and gas company in the world, was achieved at the expense of its ethical, safety and environmental goals.

The US investigators placed the blame on Lord Browne – who was forced to resign but is still an influential figure in the oil and gas industry and as a government advisor.

There was prior to Texas city a series of other safety breaches and since Texas city there has been the Deepwater Horizon disaster in the Gulf of Mexico the financial consequences of which have been disastrous for

BP. In retrospect Lord Bowne will prove to have been the most disastrous CEO of BP in its history. His neglect of company safety will have caused in excess of £50B fines and compensation claims for Texas City and Deepwater Horizon and ruined BPs reputation.

Failure to Learn – The BP Texas City Refinery

Andrew Hopkins 2010 CCH – Wolters Kluwer business.

Previous Safety Breaches at BP plant

1. End 2005 BPs deep water production platform in the Gulf of Mexico, Thunder Horse, suffered a structural collapse and tipped sideways. BP acknowledged that the root cause of the problem was **insufficient engineering input, driven by a desire to reduce costs**. Repairs cost \$100M – rather more than getting it right in the first place.
2. March 2006 oil leaked from BP pipeline in Alaska, caused by pipeline corrosion that had not been repaired or detected. **No system was in place to inspect the pipeline for corrosion**. Evidence was then found of severe corrosion elsewhere in the system and the entire Prudhoe Bay oil production had to be shut down.
3. **These problems were widely attributed to cost cutting pressures within BP driven by Lord Browne**

Failure to Learn – The BP Texas City Refinery
Andrew Hopkins 2010 CCH – Wolters Kluwer business.

4. In 2003 BP was fined for manipulating the US stock market – under Lord Browne’s watch.

5. In 2004 BP admitted to manipulating the North American propane market so as to create shortages so that BP could then profit – again under Lord Browne’s watch.

6. See previous slide on previous incidents at this site.

7. In 20th April 2010 The Deepwater Horizon disaster – see Andrew Hopkins – Disastrous Decisions 2012 CCH for a detailed analysis of the safety management failures by BP at this incident – for which they were severely fined and which nearly destroyed the company - \$40B+ fines and costs.

Failure to Learn – The BP Texas City Refinery

Andrew Hopkins 2010 CCH – Wolters Kluwer business.

The Texas City Refinery Explosion – cause.

Operators overfilled a 170 ft. distillation column. Operators are supposed to maintain the liquid in the column at a low level to give room for gas above to escape. In this case they filled the entire column with petroleum liquids.

A mixture of liquid and gas flowed out of the gas line at the top of the column, travelled through emergency overflow piping and was discharged from a tall vent 100s of ft away from the column. Nearly a road tanker of gasoline was released in under two minutes. **This vent should have had a flame to ignite any discharge. But this flame was not operating at the time and a vapour cloud formed at ground level, spread and was eventually ignited causing a severe vapour cloud explosion in which was engulfed residential caravans for maintenance workers on site, that should not have been there.**

This is a sequence of events, none of which should have happened and represent a major breakdown in safety management at the plant.

All these events were foreseeable risks and operating procedures should have ensured that they did not happen.

Failure to Learn – The BP Texas City Refinery

Andrew Hopkins 2010 CCH – Wolters Kluwer business.

Initially BP blamed and sacked the staff on the column start up on the day due to their failure to follow procedures.

1. Procedures specifying the required liquid level were ignored.
2. The rate of heating was higher than specified
3. Employees had signed a document saying they had carried out pre-start up checks, when they had not.
4. The process supervisor has absented himself for some hours during the start up (to attend a child's school play).

The company said that the failure to follow procedures was negligent.

Fire and Safety Law 2016
Professor Gordon E. Andrews
School of Chemical and Process Engineering, Univ. Leeds, UK

Failure to Learn – The BP Texas City Refinery
Andrew Hopkins 2010 CCH – Wolters Kluwer business.

However, CSB established that it was the site management that was at fault, driven by cost saving measures that were traced back to Lord Browne, the CEO.

BP at Texas City had a culture of ‘casual compliance’ with safety requirements. There were lots of notices urging compliance, but actually the site did not have the necessary supervisory resources to carry out safety compliance audits and **there was no attempt by management to ensure compliance with start-up procedures. Operators were left to their own devices and non-compliance became the norm.**

BP inadvertently encouraged non-compliance as the start-up procedures were not updated even when shown to be inadequate – so workers developed start up procedures that worked normally. **The start up procedures were certified annually with no attempt to verify with operators that the procedures were in fact adequate. Thus the operators saw that the procedures were not strict instructions but guidance. Operators were even allowed to write N/A against some steps and continue the start up using alternative methods.**

Prior to start up operators had notified deficiencies in equipment and instrumentation to management and no action was taken. Request for repairs had been ignored by management. Documents stated that checks had been done were falsified!

Fire and Safety Law 2016
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School of Chemical and Process Engineering, Univ. Leeds, UK

Failure to Learn – The BP Texas City Refinery
Andrew Hopkins 2010 CCH – Wolters Kluwer business.

In seeking to understand why the operators did what they did, we should not lose sight of the fact that it was physically possible to fill the column to the top and this should have been prevented by a failsafe device.

Also there is a long history in the petroleum industry of accidental discharges caused by overfilling of distillation columns. Various authorities have recommended that automatic shutdown devices should be installed on such columns to prevent overfilling. BP's management chose not to follow that advice. It is thus clear that what happened was foreseeable.

Had a cut out device been in operation, the accident could not have happened. In this sense, the absence of the device was the cause of the accident and this was a management responsibility.

There was also no liquid level instrumentation to tell the operators that they had overfilled the column – this was a management failure as the column design was substandard. The existing level control instrument was set at the desired level and indicated roughly the correct level – but this was the instrument that had been reported as malfunctioning that was not repaired and the start-up was not prevented – again a management safety failure.

Two other ways of detecting the overfilling were also not working or had not been fitted despite a 1994 recommendation that in and out flow measurement and their difference was displayed in the control room – following the Milford Haven explosion in the UK. All ignored by BP management.

Note: This was also the problem at Buncefield – see later

BP Refinery Explosion and Fire Texas City 23.3.05

The Guardian 8/12/06

The director responsible for running BP's Texas City oil refinery when it exploded last year killing 15 people has admitted that the site was held together by little more than "Band Aid" and "superglue" in the years running up to the disaster.

Newly disclosed documents yesterday shed fresh light on the flawed safety culture at the American arm of Britain's biggest oil company before the tragedy, in which a drumful of chemicals caught fire in the worst industrial accident in the US for a decade.

The year before the explosion, a worker was boiled alive at the refinery in the 23rd fatal accident in 30 years. That prompted the refinery's director, Don Parus, to call in external consultants. As part of the independent investigation, Mr Parus agreed to

Clearly the Texas city incident was foreseeable

be interviewed and in an extraordinary series of comments that were intended to remain anonymous he admitted he was deeply troubled by safety standards and that he did not know if he "had the energy to single-handedly turn the site round".

He observed that "killing somebody every 18 months seems to be acceptable at this site" and questioned why his staff turned up for work: "Why would people take the risk, based on the risk of not going home?"

He added that when he inherited responsibility for the refinery in 2002, he found a culture of "keep it running with Band Aids and superglue", explaining that temporary clamps were used to patch up leaky pipes and valves instead of permanent repairs - a situation that continued until the disaster. According to the local fire brigade, there was an average of one blaze a week, 50 to 80 a year.

BP Refinery Explosion and Fire Texas City 23.3.05

The Guardian 8/12/06

BP has reluctantly disclosed a mountain of internal documents about its safety practices as part of a legal settlement with a 22-year-old Louisiana woman, Eva Rowe, who lost both her parents in the Texas City blast.

An external consultants' safety report, called the Telos report, was presented to BP in January last year, two months before the explosion. It said there was "an exceptional degree of fear of catastrophic incidents" at the refinery.

Amid a range of shortcomings, the study said workers felt they were blamed by management when they got hurt and investigations were "too quick to stop at operator error as the root cause".

A focus on production, time pressure and understaffing were the root causes of a string of accidents. "Almost all interviewees say the quantity and quality of training at Texas City is inadequate, and pro-

hibits the site from having a common understanding of the core [health and safety] management system."

Safety regulators have criticised a BP cost-cutting drive ordered from London, which demanded savings of 25%, which, they say, left local managers putting money ahead of safety.

Geoffrey Gioja, co-author of the study, told lawyers in a deposition: "I have been in many places where people have said 'I could die today', many places where they all knew it, but I was surprised by how many people volunteered that, as they go through the gate every morning, this is what they are thinking about and they are concerned about going home.

"They were very serious and very sombre and the next moment they would say 'but I don't want to do anything to lose my job'."

BP under fire from new safety report

Guardian 22-1-07

Dan Milmo

BP is to receive another damning indictment over the Texas City refinery explosion when a new report links the disaster to cost-cutting by the British oil group.

Carolyn Merritt, chairwoman of the US chemical safety board (CSB), a government-backed agency, said there was an "iron-clad case" for pinning some of the responsibility on budget cuts. The report, due on March 20, will argue that there was a "causal relationship" between reductions in maintenance budgets and the explosion at the Texas City refinery in March 2005, which killed 15 people.

The legacy of Lord Browne, BP's outgoing chief executive, was tarnished last week when a US independent panel of experts said BP appeared to have had a "corporate blindspot" on safety.

The report presided over by James Baker, the former US secretary of state, however, did not attribute the blame to cost-cutting at the plant. Ms Merritt said that the CSB report would go even further

and become the first investigation of the explosion to make cost-cutting a key factor in the incident.

She said: "Budget cuts had an impact on safety and that impact on safety had a causal relationship with what happened on March 23.

"We have an iron-clad case for the impact of cost-cutting on safety. We will be

84%

The percentage by which the sum that BP had spent maintaining the Texas City refinery dropped between 1992 and 2000

making those conclusions in our report."

She added that a series of "geyser-like releases" of flammable liquid similar to the one that caused the explosion had already occurred, but a culture of "complacency and disregard for the inherent danger of what was being done" existed at all levels of the company.

"The message that was communicated

was that cost-cutting and maximising profits was the most important thing," she said.

A BP spokesperson denied that cost efficiencies, an essential part of the rationale for acquiring Texas City's former owner Amoco in 1998 had played a role in the blast. Lord Browne said last week that BP had never refused a manager's request for safety-related investment.

The CSB says that maintenance spending at Texas City fell by 41% between 1992 and 1998, when the facility was controlled by Amoco. Between 1992 and 2000 the fall was even greater, at 84%. At the time, BP internal reports stated that funding was too low but spending was not increased, the CSB will argue, although BP boosted spending after the accident in 2005.

The CSB cannot impose fines or bring criminal charges. However, it can make recommendations to regulatory bodies such as the environmental protection agency and the occupational safety and health administration, which fined BP \$21m (£10.6m) following the Texas City explosion.

The fines

Failing to have adequate maintenance procedures at Texas City refinery, resulting in 2005 explosion that killed 15 people.

Verdict \$87m fine (4 times the previous fine for safety breaches). Scores of civil cases still pending. Plus \$13M later for 409 safety violations at the plant). Civil cases settlement costs ~£1B

Violation of regulations over monitoring corrosion in its Alaskan pipelines causing 4,800-barrel oil spill.

Verdict \$20m in fines and restitution; three-year probation.

Manipulation of propane market.

Verdict \$303m fine.

Individual charges against four former BP propane traders remain.

Total cost ~\$1.4B + the \$1B cost to rebuild the refinery = \$2.4B total

Note that the fines for the health and safety issues at Texas City, although large are dwarfed by the fines for the manipulation of the propane market in the US. This indicates that health and safety does not have the same seriousness as financial irregularities, even though people die in health and safety incidents such as this.

The British company's problems in America have severely harmed its reputation among the public, interest groups and politicians. Its executives have come in for vitriolic criticism on Capitol Hill. In January, an independent report by the former secretary of state James Baker found systemic lapses in the company's safety culture - a conclusion which contributed to Lord Browne's eventual departure.

At one congressional hearing, the House energy committee chairman, Joe Barton, expressed outrage at BP's failure to maintain crucial machinery adequately: "This comes from a company which prides itself in their ads on protecting the environment. Shame! Shame! Shame!"

Granta Nakayama, assistant administrator at the Environmental Protection Agency, added: "BP must take a long, hard look at its decisions, acts and omissions that led to today's guilty plea and must take whatever steps are necessary to ensure they never happen again."

BP Refinery Explosion and Fire Texas City 23.3.05

Statement from CSB Chairman John Bresland on 5th Anniversary of Fatal BP Texas City 2005 Explosion – Statement on **23.3.2010**

Today would be an appropriate time for company management to pause and personally pledge to do everything in their power to prevent this kind of catastrophic accident from happening at their refineries. And in my view it would also be **appropriate for BP to recommit to safety** in a way that builds on the steps it has taken in the aftermath of the Texas City tragedy.

In the CSB's final investigation report issued two years after the accident, we found organizational and safety deficiencies at all levels of the BP Corporation. It was the most comprehensive and detailed investigation the CSB has ever done. Our investigation team turned up extensive evidence showing a catastrophe waiting to happen; **that cost-cutting had affected safety programs and critical maintenance; production pressures resulted in costly mistakes made by workers likely fatigued by working long hours; internal audits and safety studies brought problems to the attention of BP's board in London, but they were not sufficiently acted upon.** Yet the company was proud of its record on personnel safety.

I urge everyone involved in operations and safety programs at refineries to take time to visit the CSB's BP investigation web page, review the key findings in the report, and ask "Is any of this happening at my facility?" I also recommend taking a lunch hour to view with your colleagues the CSB Safety Video "Anatomy of a Disaster", an extensive examination - with computer animation - of the factors that caused the BP tragedy.

20th April 2010 – The Deepwater Horizon disaster occurred – BP safety at fault!

BP sells Texas City refinery for \$2.5bn

The Guardian, 9.10.12 p. 21.

Julia Kollewe

BP is close to reaching its \$38bn disposals target after selling its Texas City refinery, where 15 people died and 170 were injured in an explosion in 2005, to Marathon Petroleum for \$2.5bn (£1.55bn).

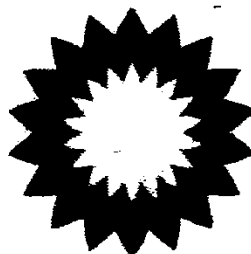
The sale ends a sorry chapter in BP's history: it had to pay \$13m in July to settle 409 safety violations found by the US occupational safety and health administration following the disaster, which was the worst industrial accident in the US for a generation. It happened when workers overfilled a container with volatile chemicals, causing an explosion.

The settlement removed a major hurdle for selling the refinery, which turns 475,000 barrels of oil a day into petrol and jet fuel. Two years ago, BP was fined a record \$50.6m for failing to fix hazards at the site near Houston, Texas, and agreed to spend \$500m on safety improvements.

Keith Casey, Texas City refinery manager, said the site had been transformed

through an increased focus on safety and in recent months had returned to profitability. "It does not, however, fit with the long-term strategic direction of BP's global refining portfolio," he said.

The sale price is made up of \$600m in



BP has been trying to raise cash for the huge costs of the Deepwater oil spill by selling off 'non-core' assets such as the Texas plant

cash, \$1.2bn for inventories and \$700m that Marathon will pay BP over the next six years in an "earn-out" arrangement based on future margins. The 2,200 staff are expected to transfer to the new owner, which already has a small refinery there.

BP embarked on a \$23bn selling spree to raise cash for liabilities and fines after the Deepwater Horizon oil spill in the Gulf of Mexico in 2010. Then last year it raised the target amount it wanted to raise from sell-

ing "non-core" assets to \$38bn. The sale of the refinery, which includes liquefied natural gas pipelines and four marketing terminals in the south-east US, follows the recent offloading of BP's Carson refinery in California and brings total disposals to \$35bn.

BP has been keen to scale down its refining operations, where profit margins are thin. The company is confident of reaching its \$38bn target next year, although it has not put any other assets up for sale.

BP took a \$38bn charge related to the Gulf disaster. So far it has spent \$14bn cleaning up the spill; paid out more than \$8bn in claims; and agreed a deal with affected individuals and small firms which is expected to cost another \$8bn.

The US justice department expects to find BP guilty of gross negligence in a court case that restarts in January. If it can prove gross negligence, it can triple the damages BP may have to pay to \$21bn.

BP sold its Carson refinery to Tesoro for \$2.5bn but is investing heavily in three US sites in Indiana, Washington and Ohio.

This sale was to raise money to pay the fines for Deepwater Horizon

Was it foreseeable?

Prof. Gordon E. Andrews, School of Chemical and Process Engineering, U. Leeds

Disastrous Decisions – Gulf of Mexico Blowout. Andrew Hopkins CCH 2012

The floating rig **Deepwater Horizon** had just completed drilling an ultra-deep well (Macondo) in 1.5km deep water and the drill was 4km below the seafloor. The drilling was behind schedule but was complete and people were departing the platform when at 9.45pm drilling mud spewed out the top of the derrick, there was associated liquid and gaseous hydrocarbons. An explosion followed and the subsequent fire destroyed the platform. **11 died from the 126 on the platform.**

The blowout preventer (BOP) failed to operate and it took 87 days to cap the well and the oil that leaked resulted in an environmental disaster. Compensation costs from BP \$40B and rising.

However, the incident was a result of organisational failure rather than technological complexity.

It was not a failure to foresee the event that occurred, but a failure to take adequate precautions to prevent the event happening.

The US regulators treated BP severely partially because their reputation for safety was in the toilet following the 2005 Texas City explosion and other safety issues around their US plants.

Was it foreseeable?

Prof. Gordon E. Andrews, School of Chemical and Process Engineering, U. Leeds

Disastrous Decisions – Gulf of Mexico Blowout. Andrew Hopkins CCH 2012

The well had been drilled down to the oil and gas bearing sands and the drill rig was ready to move to another job.

The bottom of the well had to be plugged with cement so that it could be left in a safe state ready for BP to connect a production rig at a later date.

The cement team declared it a success and ‘met the criteria that had been established by the engineering group for deciding whether the job was successful’. This was a tragic error of judgement.

In fact the cement job was a failure and had failed to achieve ‘zonal isolation’ – meaning that oil and gas were free to enter the bottom of the well and to blow out, as soon as the opportunity arose.

The success of the cement plug was not tested and BP contractors were on site that could have determined whether the plug was a success – a cement bond log (CBL). The cost of this was \$128,000 and would take 12 – 18 hours and the drill rig cost \$1M per day. The CBL were flown off site as the cement job was declared a success!

The consequences of a failure of the cement seal was clearly foreseeable and the circumstances around the decision by contractors to declare the cement plug a success are critical to why the event occurred.

Lecture to UKELG 21st Sept. 2016 University of Leeds

Was it foreseeable?

Prof. Gordon E. Andrews, School of Chemical and Process Engineering, U. Leeds

Disastrous Decisions – Gulf of Mexico Blowout. Andrew Hopkins CCH 2012

The failure of the cement job.

Macondo engineers chose a particular well design (configuration of pipes and joints) that was cheaper and would also make it easier to begin production.

However, this design also made it more difficult to achieve a good cement job. They would be restricted to using a relatively small quantity of cement, which reduced the margin for error; they would need to pump the cement down the well at a slower than optimum rate; and they would need to use a lighter than normal cement, foam cement, that was relatively unstable. This process was so difficult that the engineers considered a last minute change to a standard plug, but in the end persevered with the more risky plug.

The Presidential Commission concluded that although the precise mechanism of plug failure was not known, **the decision of the Macondo engineers to accept these risks contributed to the cement failure. If a conventional plug had been used the disaster would not have happened.**

A greater risk had been taken to save costs and the results were foreseeable and adequate precautions had not been taken to offset the increased risk.

At the time the **BP philosophy was 'its good to take risks'**. They meant commercial oil exploration risks, but this led to risks in safety being taken that were not justified. The balance required between the consequence of something going wrong and the cost of preventing it had been ignored and BP is £40B+ worse off as a consequence.

Was it foreseeable?

Prof. Gordon E. Andrews, School of Chemical and Process Engineering, U. Leeds

Disastrous Decisions – Gulf of Mexico Blowout. Andrew Hopkins CCH 2012 p.26

The Macondo engineers were aware of at least four possible ways in which the cement job may fail to achieve zonal isolation.

- 1. Loss of cement into the oil and gas sands**
- 2. Instability of the nitrogen foam cement**
- 3. Channelling in the annulus**
- 4. Contamination of the cement.**

However, the only evidence they sought that the cement job was good was in relation to 1. loss of cement into the oil and gas sands.

They had the technical knowledge of the other three modes of failure but did not include them in their risk analysis – thus this event was foreseeable. When they declared the job a success it was on the basis of 1 and this was not based on actual test evidence but on the personal opinions of the team – there was no leader who said we must do the tests. 5 days before the failure BPs ‘management of change’ process which authorised the risky drilling process, also only considered the first mode of failure. So the advice from BP was also negligent and they were liable.

Was it foreseeable?

Prof. Gordon E. Andrews, School of Chemical and Process Engineering, U. Leeds

Disastrous Decisions – Gulf of Mexico Blowout. Andrew Hopkins CCH 2012 Ch.9

7 hours before the blowout there was a visit to Deepwater Horizon by four VIPs of BP/Transocean management. They were on the rig when it blew up, but all 4 survived. All four were expert drilling engineers. A major purpose of the visit was to emphasise the importance of safety. Yet they watched what they knew were unsafe operations taking place and did not intervene.

Prior to the disaster the Deepwater Horizon rig had operated for 7 years without a major safety incident and the VIPs were there to congratulate the staff and to learn lessons on why their safety was so good!

These VIP visitors were very much focussed on safety.

These VIP visitors observed the fatal discussion on how to do the well integrity test – it should have been clear that the team had got this horribly wrong. But the BP executive asked no questions.

The Transocean (rig owners and operators) VIP observed that the drillers were confused over whether the cement job was good. He sensed that they needed help – but the VIPs did not want to interfere!

Was it foreseeable?

Prof. Gordon E. Andrews, School of Chemical and Process Engineering, U. Leeds

Disastrous Decisions – Gulf of Mexico Blowout. Andrew Hopkins CCH 2012

Had any of these VIPs asked the key question, ‘how are you monitoring flows?’ they would have found out that there was no effective monitoring and hence no way of knowing if there was loss of cement into the oil and gas sands.

Had they then intervened to ensure effective monitoring, the disaster would not have happened.

The VIPs were there to audit the safety of the cement job and they observed the decision making process that led to the disastrous decision that the cement seal was good when it was not. A decision that was made without the test procedures that would normally be used.

These VIPs knew that Transocean had had a near disastrous blowout in the N. Sea four months earlier under very similar circumstances. The VIPs were there to check that a similar near disaster was avoided and yet they did not interfere in a process that was clearly going wrong.

Why? They did not want to disrupt activities which would be costly.

These VIP audits were clearly not fit for purpose even though they were all experts in drilling and cementing the well. They did not seem to want to appear to doubt the professionalism of the team by asking searching questions. Note that the USA had no safety case regime as in the UK.

Lecture to UKELG 21st Sept. 2016 University of Leeds

Kleen Energy Natural Gas Explosion (2)

Initial calculations by CSB investigators reveal that approximately 400,000 standard cubic feet of gas (11,327 m³ ~ 8.6 Tonnes ~ 430 GJ energy) were released to the atmosphere near the building in the final ten minutes before the blast.

That is enough natural gas to fill the entire volume of a pro-basketball arena with an explosive natural gas-air mixture, from the floor to the ceiling.

This gas was released into a congested area next to the power block building. This congested area likely slowed the dispersion of the gas, *but it would increase the severity of any explosion due to the generation of turbulence and overpressures would be higher.*

The gas built up above the lower explosive limit of approximately 4% in air and was ignited by an undetermined ignition source.

Kleen Energy Natural Gas Explosion (1)

Location: Middletown, CT

February 07, 2010

Accident Type: Flammable Vapor

Statement of CSB Investigations Supervisor Don Holmstrom Updating the Public on the CSB's Investigation of the Catastrophic Accident at Kleen Energy, Middletown, Connecticut

Thursday, February 25, 2010

Six workers were fatally injured during a planned work activity to clean debris from natural gas pipes at Kleen Energy in Middletown, CT. USA.

To remove the debris, workers used natural gas at a high pressure of approximately 650 pounds per square inch (45 bar). The high velocity of the natural gas flow was intended to remove any debris in the new piping. During this process, the natural gas found an ignition source and exploded.

6 people were killed.

This was clearly a foreseeable incident and is one of gross stupidity

**Buncefield - Hertfield Oil Storage Ltd.
Owned by Total UK Ltd (60%) and Texaco (40%)
11th December 2005**

The Guardian 10.5.06



The Buncefield fire, which sent black smoke across southern England, was the biggest in Europe since the second world war Photograph: Hertfordshire Police/AFP

**Petrol gushing from overfilled tank
caused explosion at Buncefield**

Other incidents similar to Buncefield - 1

Location	Date and time	Comments – background	Comments – explosion
1 Houston, Texas, USA	April 1962	'Severe leak' from a gasoline tank. Almost windless conditions. Ignition near adjacent highway.	Described as a 'blast', but no details are available.
2 Baytown, Texas, USA	27 January 1977	Overfilling of a ship with gasoline.	Few details are available, but it is likely that there would have been congestion.
3 Texaco, Newark, New Jersey, USA	7 January 1983 After 00.00 hrs	Overfilling of a tank containing unleaded gasoline. 114-379 m ³ (80-265 tonnes) of gasoline released. Slight wind, ignition source 300 m away.	Relatively uncongested area. High overpressures reported, but not quantified. Three minor explosions preceded the main blast.
4 Naples Harbour, Italy	21 December 1985	Overfilling of a tank containing unleaded gasoline. 700 tonnes escaped. Low wind speed (2 m/s).	Relatively congested area. The tank overtopped 1.5 hours before ignition. Various overpressures estimated from damage analysis, but they are minimum values (eg >48 kPa).

Other incidents similar to Buncefield - 2

5 St Herblain, France	7 October 1991 04:00 hours	Leak of gasoline from a transfer line into a bund. Wind <1 m/s. 20 minutes delay, ignition in car park c. 50 m away. Volume of flammable cloud est. 23 000 m ³ .	Presence of parked petrol tankers may have been sufficient to generate turbulence. High overpressures produced, but not quantified.
6 Jacksonville, Florida, USA	2 January 1993 03:15 hours	Overfilling of a tank containing unleaded gasoline. 50 000 gallons (190 m ³ , 132 tonnes) released.	High overpressure produced, but not quantified.
7 Laem Chabang, Thailand	2 December 1999 23:25 hours	Overfilling of a gasoline tank. Few details.	High overpressure produced, but not quantified. Relatively low congestion in the area.

The Buncefield Investigation: Third progress report, 9th May 2006
<http://www.buncefieldinvestigation.gov.uk>

Five previous incidents of explosions and fires following overfilling of gasoline storage tanks shows that what happened at Buncefield was clearly foreseeable – it had happened before, several times and should have been in the risk analysis.

The Buncefield final report also has specific recommendations to similar events occurring - **All are obvious, why on a COMAH site were these deficiencies allowed – HSE has some responsibility!**

1. Improved tank overfill prevention procedures.
2. Review management of maintenance procedures
3. **Fit an automatic overfill prevention system that is physically separate from that of level detection.**
5. Overfill prevention system must be physically tested on a regular basis.
6. The receiving tank storage site must have control of the tank feed process and NOT the refinery sending the flammable fluids.
8. Review of all components on tank overfill prevention.
9. **Records of all fluid movements to and from tank farms must be kept and be readily available.**
11. Review COMAH site classification of explosion hazards
13. **Fit flammable gas detectors around the site.**

The permit to work (PTW) system failures at Pipe Alpha

The PTW system was carried out by a contractor whose supervisor did not inspect the job site before suspending the permit overnight. **He did not discuss the non-completion of the work with the process supervisor but signed off the permit and left it on the control room desk.**

The condensate injection pump suction and delivery valves were not secured against inadvertent opening by locks. The permits for the major overhaul and the relief valve work were not cross-referenced one to the other. However, these were not isolated incidents of PTW failures. **The operator's written PTW procedure did not mention the need to cross-reference permits where one piece of work may affect another. It made no reference to methods of isolation or locking off valves to prevent inadvertent recommissioning.**

Numerous errors were regularly made in the way permits were completed on Piper Alpha. Multiple jobs were undertaken on a single permit. It was common practice for maintenance supervisors to leave permits on the control room desk without discussion as to the state of the work with process staff. Process supervisors frequently signed off permits before having the state of the equipment checked out.

Neither the operator's own staff or contractor's supervisors were provided with formal and regular training to ensure they operated the system as laid down. All training was 'on the job', that is learning from other supervisors. This has a part to play, but as the sole method of training it suffers from the crucial weakness of perpetuating or accumulating errors.

Trevor Kletz, Learning from accidents, 1994, p.177.

What happened at Pipe Alpha was foreseeable due to long standing problems with the operation of permit to work systems – an accident was inevitable.

Problems with the Pipe Alpha Safety Auditing

Trevor Kletz, Learning from accidents, 1994, p.181.

The way that management ensures that its decisions on safety procedures are carried out in practice is to regularly audit operations (*this has been a requirement of the HSWA since 1974 – see later section on safety inspections*). **The deficiencies found in the inquiry into Pipe Alpha were readily found, so why were they not apparent to the operating management.**

The problem was that the safety management monitoring procedures were themselves inadequate. The PTW system had been audited and no deficiencies reported. An annual fire safety audit was undertaken but the report had never mentioned the problem of corrosion and blocked spray heads. An audit had highlighted the problem of the manual start of the diesel water back-up pumps but the recommendations were not acted on.

Clearly there was no shortage of safety auditing on Piper Alpha. What was deficient was the quality of the auditing and the feedback of action and checking that that action had been carried out, that was at fault.

Not only were departures from laid-down procedures not picked up, but the absence of critical comment in audit reports lulled the senior management into believing that all was well.

This incident shows clearly that Management is responsible for all the deficiencies found. They also have the legal responsibility and the power to act. The safety department is NOT responsible, they are there to monitor and audit the process.

The lack of a systematic evaluation and plans for action for worst case incidents was a direct management responsibility. The lack of adequate auditing was management's failure, they should have foreseen what happened due to their inadequate permit to work system.

BHOPAL 3.12.1984 – 2153 dead (some estimate 10,000+)

Bhopal – Anatomy of a crisis, P. Shrivastava, 2nd Ed., 1992, PCP Publishing.

This was the worst industrial disaster in history.

A leak of over 25 tonnes of highly toxic methyl isocyanate (MIC) occurred from a storage tank. MIC is an intermediate in the manufacture of the insecticide carbaryl the active ingredient of Sevin. It became contaminated with water and a runaway reaction occurred. It was known that MIC and water have an exothermic reaction.

Four levels of protective equipment that should have prevented or minimised the discharge were out of action:

- 1. The refrigeration system which should have cooled the storage tank was shut down,**
- 2. the scrubbing system which should have absorbed the toxic vapour was not available**
- 3. the flare system which should have burnt any vapour which got past the scrubbers was out of use.**
- 4. The nitrogen atmosphere above the MIC tank was out of action.**

All these are safety management failures. **Clearly a foreseeable event.**

Houston, Texas, September 30, 2015 -- An ongoing investigation by the U.S. Chemical Safety Board (CSB) of the November 15, 2014, toxic chemical leak that killed four workers at the E. I. du Pont de Nemours insecticide plant in La Porte, Texas, has uncovered flawed safety procedures, design problems and inadequate planning.

Nearly 24,000 pounds of deadly methyl mercaptan escaped in the middle of the night through two valves in a poorly ventilated manufacturing building. In one area of the plant, operations personnel attempted to clear blocked piping. Later in a different area, two workers opened valves in response to what they believed was a routine, unrelated pressure problem. The **two workers were killed when liquid methyl mercaptan drained from the open valves, filling the room with toxic vapor. One of those workers made a distress call, and two additional workers died responding to that call.**

CSB Chairperson Vanessa Allen Sutherland said,
“DuPont has long been regarded as a safety leader in the chemical industry, but this investigation has uncovered weaknesses or failures in DuPont’s safety planning and procedures. These interim recommendations lay out what the company at its La Porte facility should do to protect workers and the public.”

DuPont made insecticides, herbicides, and other products in separate units at the facility in La Porte. Methyl mercaptan is a raw material of Lannate® , a top-selling, broad-spectrum insecticide. Production of insecticide has not yet resumed at the La Porte facility. DuPont has agreed to address the proposed CSB recommendations as part of its plan to safely restart the facility.

They realized that when heated, methyl mercaptan would expand and would need a safe place to vent, and two valves leading to vent piping were opened. **But this plan had not gone under safety review as required by the company's own standards. Moreover, the CSB learned that there were no written procedures to guide operations or to track the success of the plan or progress toward clearing the entire methyl mercaptan feed line.**

At 2:45 a.m., the methyl mercaptan level in the storage tank began dropping as the hydrate liquefied and the toxic chemical flowed toward the open waste gas vent header. As methyl mercaptan began to flow in the vent piping, high pressure alarms for process equipment connected to the vent header registered on computer consoles in the control room. Operators did not realize that the two problems – the hydrate blockage and the high pressure – were related, the investigators said.

Two operations workers went to drain the waste gas vent header piping and liquid methyl mercaptan escaped into the building, where it readily vaporized, filling the room with a highly toxic gas. Although one of the workers made a distress call, both died, unable to escape the building. Four additional operators responded to the distress call and entered the manufacturing building. Two of them were brothers—they died together on the same floor as the release. The other two operators survived.

The release continued for another hour and a half until the valves were closed. DuPont estimated that approximately 24,000 pounds of toxic methyl mercaptan was released during the November 15 incident.

“Neither workers nor the public are protected by DuPont’s toxic gas detection system,” investigators said. **The building where the workers died was not equipped with an adequate toxic gas detection system** to alert workers to the presence of dangerous chemicals. Also, **two rooftop ventilation fans were not working**, despite an “urgent” work order written nearly a month earlier. However, investigators said even working fans probably would not have prevented a lethal atmosphere inside the building due to the large amount of toxic gas released.

The La Porte incident marks the third CSB investigation into a fatal accident at DuPont plants in the past five years. One worker was killed in 2010 when a steel hose carrying phosgene gas burst at a Belle, W.Va., plant. Later that year, a welder perished in an explosion at a Buffalo, N.Y., facility.

Among the investigators' main recommendations:

- **Perform Inherently Safer Design Review**
- **Ensure the Manufacturing Building is Safe for Workers**
- **Provide Relief System Design that is Safe for Workers and the Public**
- **Complete More Robust Process Hazard Analyses**
- **Assure Active Workforce Participation**
- **And Promise Public Accountability and Transparency**

All of the above were legal requirement in the USA and are legal requirements under European law for high hazard chemical plant. Indeed the HSWA 1974 in the UK required all the above.

The DuPont La Porte plant was once a leader in applying inherently safer design.

It is well known for pro-active changes made to the facility after the devastating December 3, 1984, accident in Bhopal, India. Considered the worst industrial accident in history, thousands of people were killed during a release of methyl isocyanate (MIC) at a Union Carbide insecticide plant.

That accident triggered changes throughout the chemical industry, including the DuPont La Porte insecticide unit that also used MIC.

Investigator Tillema said, “DuPont made modifications then that incorporated inherently safer design principles for methyl isocyanate, including an open building structure with equipment to direct potential leaks of toxic chemicals to an incinerator.

However, DuPont did not take the same steps with other highly toxic chemicals at La Porte such as methyl mercaptan and chlorine, also used to make Lannate®.”

US Chemical Safety Board (CSB) Sept. 15th 2015.

Major accidents and deaths continue to happen in circumstances that were foreseeable – liability is then with the company management.