WELCOME

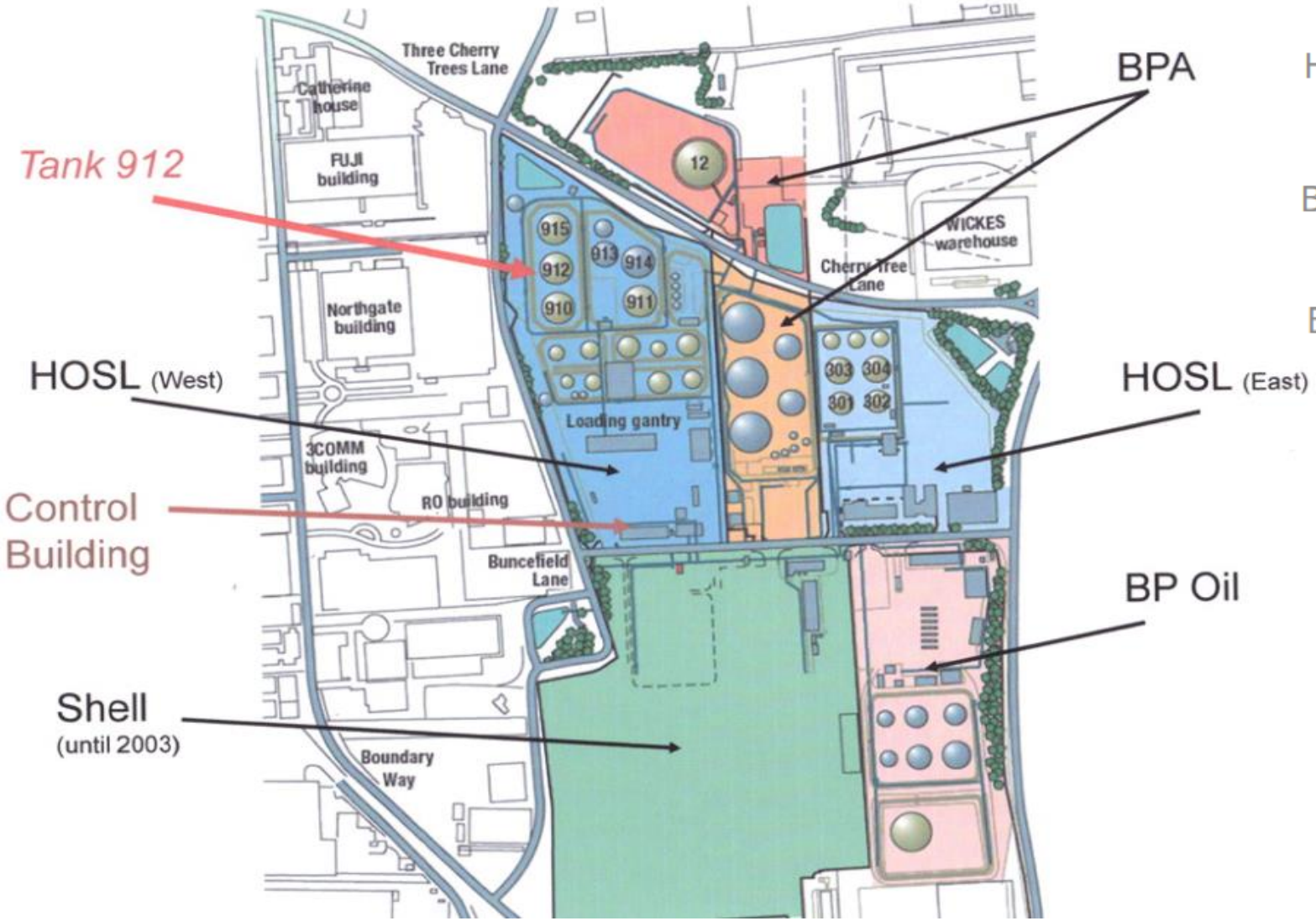
With us you are Number One | ENGEN

Velephi Manzini

PETRONAS

1. Health and Safety Executive (HSE) and the
2. Environmental Agency (EA), and the
3. Major Incident Investigation Board (MIIB) that was set up by the Government;
4. Buncefield Standards Task Group (BSTG) and
5. Process Safety Leadership Group (PSLG) of ways to implement the recommendations from the MIIB;

BUNCEFIELD TERMINAL LAYOUT



HOSL: Hertfordshire Oil Storage Ltd;

BPA: British Pipelines Agency;

BP: British Petroleum.

Credit [The Buncefield Incident – 7 Years on: A Review - Colin Howard, 2013 (sagepub.com)]

With us you are Number One | ENGEN

INCIDENT TIMELINE

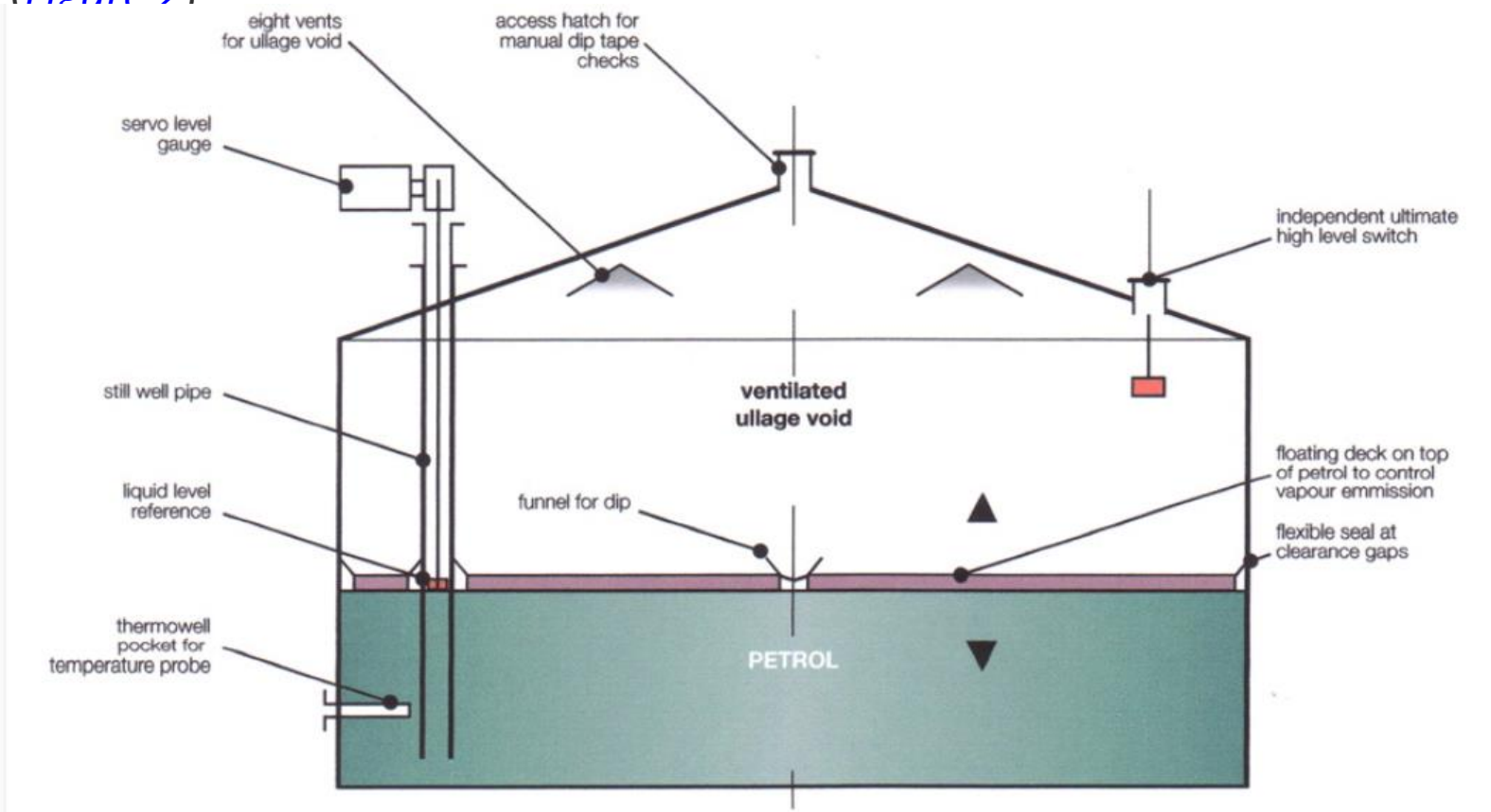
- The immediate sequence of events that led to the Buncefield explosion started on Saturday 10 December 2005 when tank 915 on HOSL was set up to receive a parcel of unleaded gasoline directly from the FINA pipeline, while also exporting to road tankers. Tank 915 was nearly empty when the import started at a net import rate of ~140 m^3/h, controlled by the team in the HOSL(W) control room. At this filling rate, there was sufficient space in tank 915 to allow filling to continue well into daytime on 11 December.

- Later that day, the isolation valves on tank 912 were opened, and the route was set up by the HOSL team to receive an 8400 m^3 parcel of unleaded gasoline from BPA via the UKOP(S). The transfer was started by BPA shortly before the evening shift change at HOSL on 10 December.

- The pumping rate was around 500–550 m^3/h, set by the BPA control room at Kingsbury, with the parcel scheduled to take about 14 hours to deliver into HOSL. At the start of the transfer, tank 912 had an available ullage of just less than 5000 m^3, necessitating a change of delivery tank to accommodate the remainder of the parcel, at some time during the night around 03:00–04:00 a.m.

- During this same time frame, HOSL was also receiving a parcel of diesel fuel from the UKOP(N) into tank 908.

- At around 03:15 a.m., the tank gauge on tank 912 became stuck, and from then on, the ATG system recorded a static reading of 12,188 mm (96.4% of the working tank capacity), but the tank continued to fill at a rate of ~550 m^3/h. The HOSL operating team had no indication of the flow coming from the UKOP(S) into tank 912 (*Figure 2*)



- It became clear early on that documentary evidence and what was found on the site did not always match.
- During the investigation, it emerged that rather than being unique, Buncefield was only the latest of seven similar incidents identified in the previous 43 years (and there have been two others since).

- The BSTG generated guidance in the following areas:
  - Safe management of product transfers;
  - Tank overfill protection, including tank operating practices and staffing levels and safety margins;
  - Effective shift handover arrangements;
  - Safety integrity and independence of overfill systems;
  - The use of fire safe valves and Remote Operated Safety Shut-off Valves (ROSOVs);
  - Containment measures.

- The primary technical causes of the incident were that the output from the ATG level transmitter on tank 912 had stuck in one position and the output had flatlined below the alarm settings,
- and that the independent high alarm switch was inoperable because the testing lever had not been padlocked in the horizontal position.
- The investigation also identified that the tank 912 level transmitter had similarly flatlined on at least 14 occasions in the previous 3 months, but no effective action had been taken to find the root cause or repair the fault completely.
- Fault reporting, management of change, safety critical systems identification and the use of procedures of various types were all the subject of further study.
- The loss of containment issues arising from the failures of the bunds to contain the gasoline and firefighting materials, and the failure of the tertiary containment to retain any leakage within the Buncefield site.

- Emergency preparedness for, response to and recovery from incidents.

- A total of 32 recommendations about the enhanced involvement of local authorities and emergency services of all kinds in the emergency planning at Major Hazardous Installation sites, and also the role of central government and other agencies in the aftermath of a major incident.

- One aspect developed from this is the enhanced requirement for water for firefighting, how and where water should come from and how it should be recovered once it has been used on the fire, with implications for secondary and tertiary containment requirements.

MIIB RECOMMENDATIONS

1. Systematic assessment of Safety Integrity Level (SIL) requirements (recommendation 1);

2. Protecting against loss of primary containment using high-integrity systems (recommendations 2–10);

3. Engineering against escalation of loss of primary containment (recommendations 11–16);

4. Engineering against loss of secondary and tertiary containment (recommendations 17 and 18);

5. Operating with high-reliability organisations (recommendations 19–22);

6. Delivering high performance through culture and leadership (recommendations 23–25).

- Systematic assessment of safety integrity level requirements 8
- Recommendation 1
- Protecting against loss of primary containment using high integrity systems 10
- Recommendations 2-10
- Engineering against escalation of loss of primary containment 14
- Recommendations 11-16
- Engineering against loss of secondary and tertiary containment 16
- Recommendations 17-18
- Operating with high reliability organisations 18
- Recommendations 19-22
- Delivering high performance through culture and leadership 20
- Recommendations 23-25

RECOMMENDATION 1

- The Competent Authority and operators of Buncefield-type sites should develop and agree a common methodology to determine **safety integrity level (SIL) requirements for overfill prevention systems in line** with the principles set out in Part 3 of BS EN 61511. (ref 3) This methodology should take account of:

- the existence of nearby sensitive resources or populations;
- ▼ the nature and intensity of depot operations;
- ▼ realistic reliability expectations for tank gauging systems; and
- ▼ the extent/rigour of operator monitoring.

Application of the methodology should be clearly demonstrated in the COMAH safety report submitted to the Competent Authority for each applicable site. Existing safety reports will need to be reviewed to ensure this methodology is adopted

RECOMMENDATION 2

- Operators of Buncefield-type sites should, as a priority, review and amend as necessary their management systems for **maintenance of equipment and systems to ensure their continuing integrity** in operation.

- This should include, but not be limited to reviews of the following:
  - ▼ the arrangements and procedures for periodic **proof testing of storage tank overfill prevention** systems to minimise the likelihood of any failure that could result in loss of containment; any revisions identified pursuant to this review should be put into immediate effect;
  - ▼ the procedures for implementing changes to **equipment and systems to ensure any such changes** do not impair the effectiveness of equipment and systems in preventing loss of containment or in providing emergency response.

RECOMMENDATION 3

- Operators of Buncefield-type sites should protect against **loss of containment of petrol and other highly flammable liquids by fitting a high integrity, automatic operating overfill prevention system10 (or a number of such systems, as appropriate) that is physically and electrically separate and independent** from the tank gauging system. Such systems should meet the requirements of Part 1 of BS EN 61511 for the required safety integrity level, as determined by the agreed methodology (see Recommendation 1). Where independent automatic overfill prevention systems are already provided, their **efficacy and reliability should be reappraised in line with the principles** of Part 1 of BS EN 61511 and for the required safety integrity level, as determined by the agreed methodology (see Recommendation 1)

RECOMMENDATION 4

- ***Recommendation 1:*** The **overfill prevention system (comprising means of level detection, logic/control equipment and independent means of flow control) should be engineered, operated and maintained to achieve and maintain an appropriate level of safety integrity** in accordance with the requirements of the recognised industry standard for ‘safety instrumented systems’, Part 1 of BS EN 61511.

RECOMMENDATION 5

- All elements of an overfill prevention system **should be proof tested** in accordance with the validated arrangements and procedures sufficiently frequently to ensure the specified safety integrity level is maintained in practice in accordance with the requirements of Part 1 of BS EN 61511.

RECOMMENDATION 6

- The **sector** should put in place arrangements to ensure the receiving site (as opposed to the transmitting location) has **ultimate control of tank filling**. The receiving site should be able to safely terminate or divert a transfer (to prevent loss of containment or other dangerous conditions) **without depending on the actions of a remote third party, or on the availability of communications to a remote location.** These arrangements will need to consider upstream implications for the pipeline network, other facilities on the system and refineries.

RECOMMENDATION 7

- In conjunction with Recommendation 6, **the sector** and the Competent Authority should undertake a review of the **adequacy of existing safety arrangements, including communications, employed by those responsible for pipeline transfers of fuel.**

- This work should be aligned with implementing Recommendations 19 and 20 on high reliability organisations to ensure major hazard risk controls address the management of critical organisational interfaces.

RECOMMENDATION 8

- **The sector,** including its supply chain of equipment manufacturers and suppliers, should review and report without delay on the scope to develop improved components and systems, including but not limited to the following:

- ▼ alternative means of **ultimate high-level detection for overfill prevention** that do not rely on components internal to the storage tank, with the emphasis on ease of inspection, testing, reliability and maintenance;
- ▼ increased dependability of **tank level gauging systems** through improved validation of measurements and trends, **allowing warning of faults and through using modern sensors** with increased diagnostic capability; and
- ▼ **systems to control and log override actions**.

RECOMMENDATION 9

- Operators of Buncefield-type sites should introduce arrangements for the **systematic maintenance of records** to allow a review of **all product movements together with the operation of the overfill prevention systems and any associated facilities.**

The arrangements should be fit for their design purpose and include, but not be limited to, the following factors:

- **▼ the records should be in a form that is readily accessible by third parties without the need for specialist assistance;**
- **▼ the records should be available both on site and at a different location;**
- **▼ the records should be available to allow periodic review of the effectiveness of control measures by the operator and the Competent Authority, as well as for root cause analysis should there be an incident;**
- **▼ a minimum period of retention of one year.**

RECOMMENDATION 10

- **The sector** should agree with the Competent Authority on a system **of leading and lagging performance indicators for process safety performance**. This system should be in line with HSE's recently published guidance on Developing process safety indicators HSG254.

RECOMMENDATION 11

- Operators of Buncefield-type sites should **review the classification of places within** COMAH sites where **explosive atmospheres may occur and their selection of equipment and protective systems** (as required by the Dangerous Substances and Explosive Atmospheres Regulations 2002(ref 6)). This review should take into account the likelihood of undetected loss of containment and the possible extent of an explosive atmosphere following such an undetected loss of containment. Operators in the wider fuel and chemicals industries should also consider such a review, to take account of events at Buncefield.

RECOMMENDATION 12

- Following on from Recommendation 11, operators of Buncefield-type sites should evaluate the siting and/or **suitable protection of emergency response facilities such as firefighting pumps, lagoons or manual emergency switches**.

RECOMMENDATION 13

- Operators of Buncefield-type sites should employ measures to **detect hazardous conditions arising from loss of primary containment, including the presence of high levels of flammable vapours in secondary containment.** Operators should without delay undertake an evaluation to identify suitable and appropriate measures.

- This evaluation should include, but not be limited to, consideration of the following:
  - ▼ installing **flammable gas detection** in bunds containing vessels or tanks into which large quantities of highly flammable liquids or vapour may be released;
  - ▼ the relationship between the **gas detection system and the overfill prevention system**. Detecting high levels of vapour in secondary containment is an early indication of loss of containment and so should initiate action, for example through the overfill prevention system, to limit the extent of any further loss;
  - ▼ installing **CCTV equipment to assist operators** with early detection of abnormal conditions. Operators cannot routinely monitor large numbers of passive screens, but equipment is available that detects and responds to changes in conditions and alerts operators to these changes

RECOMMENDATION 14

- Operators of new Buncefield-type sites or those making major modifications to existing sites (such as installing a new storage tank) should introduce further measures including, but not limited to, **preventing the formation of flammable vapour in the event of tank overflow**. Consideration should be given to modifications of tank top design and to the safe re-routing of overflowing liquids.

RECOMMENDATION 15

- **The sector** should begin to develop guidance without delay to incorporate the latest knowledge on **preventing loss of primary containment** and **on inhibiting escalation** if loss occurs. This is likely to require the sector to collaborate with the professional institutions and trade associations.

RECOMMENDATION 16

- Operators of existing sites, if their risk assessments show it is not practicable to introduce measures to the same extent as for new ones, should introduce measures as close to those recommended by Recommendation 14 as is reasonably practicable. The outcomes of the assessment should be incorporated into the **safety report submitted** to the Competent Authority

RECOMMENDATION 17

- The Competent Authority **and the sector** should jointly review existing standards for secondary and tertiary containment with a view to the Competent Authority producing revised guidance by the end of 2007. The review should include, but not be limited to the following:

  - **▼ developing a minimum level of performance specification of secondary containment (typically this will be bunding);**
  - **▼ developing suitable means for assessing risk so as to prioritise the programme of engineering work in response to the new specification;**
  - **▼ formally specifying standards to be achieved so that they may be insisted upon in the event of lack of progress with improvements;**
  - **▼ improving firewater management and the installed capability to transfer contaminated liquids to a place where they present no environmental risk in the event of loss of secondary containment and fires;**
  - **▼ providing greater assurance of tertiary containment measures to prevent escape of liquids from site and threatening a major accident to the environment.**

RECOMMENDATION 18

- Revised standards should be applied in full to new build sites and to new partial installations.

- On existing sites, it may not be practicable to fully upgrade bunding and site drainage. **Where this is so operators should develop and agree** with the Competent Authority risk-based plans for phased upgrading as close to new plant standards as is reasonably practicable.

RECOMMENDATION 19

- **The sector** should work with the Competent Authority to prepare guidance and/or standards on how to achieve a high reliability industry through placing emphasis on the assurance of human and organisational factors in design, operation, maintenance, and testing.

- Of particular importance are:

  - ▼ **understanding and defining the role and responsibilities of the control room operators** (including in automated systems) in ensuring safe transfer processes;
  - ▼ **providing suitable information and system interfaces for front line staff to enable them to reliably detect, diagnose and respond to potential incidents**;
  - ▼ **training, experience and competence assurance of staff for safety critical and environmental protection activities;**
  - ▼ **defining appropriate workload, staffing levels and working conditions for front line personnel;**
  - ▼ **ensuring robust communications management within and between sites and contractors and with operators of distribution systems and transmitting sites (such as refineries);**

RECOMMENDATION 19

- ▼ prequalification auditing and operational monitoring of contractors' capabilities to supply, support and maintain high integrity equipment;
- ▼ providing effective standardised procedures for key activities in maintenance, testing, and operations;
- ▼ clarifying arrangements for monitoring and supervision of control room staff; and
- ▼ effectively managing changes that impact on people, processes and equipment.

RECOMMENDATION 20

- **The sector** should ensure that the resulting guidance and/or standards is/are implemented fully throughout the sector, including where necessary with the refining and distribution sectors. The Competent Authority should check that this is done.

RECOMMENDATION 21

- **The sector** should put in place arrangements to ensure that good practice in these areas, incorporating experience from other high hazard sectors, is shared openly between organisations.

RECOMMENDATION 22

- The Competent Authority should ensure that **safety reports submitted u**nder the COMAH Regulations contain information to demonstrate that good practice in human and organisational design, operation, maintenance and testing is implemented as rigorously as for control and environmental protection engineering systems

RECOMMENDATION 23

- The sector should set up arrangements to collate incident data on **high potential incidents** including **overfilling, equipment failure, spills and alarm system defects, evaluate trends, and communicate information on risks,** their related solutions and control measures to the industry.

RECOMMENDATION 24

- The arrangements set up to meet Recommendation 23 should include, but not be limited to, the following:

  - thorough **investigation of root causes of failures and malfunctions of safety and environmental protection critical elements during testing or maintenance, or in service**;
  - **developing incident databases that can be shared across the entire sector**, subject to data protection and other legal requirements. Examples15 exist of effective voluntary systems that could provide suitable models;
  - **collaboration** between the workforce and its representatives, duty holders and regulators **to ensure lessons are learned from incidents**, and best practices are shared.

RECOMMENDATION 25

- **The sector** should draw together current knowledge of major hazard events, failure histories of safety and environmental protection critical elements, and developments in new knowledge and innovation to continuously improve the control of risks.

- This should take advantage of the experience of other high hazard sectors such as chemical processing, offshore oil and gas operations, nuclear processing and railways.