

Lecture PT2

Risk Management using the Basis of Safety Approach

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RISK CONTROL : BASIS OF SAFETY



BASIS OF SAFETY

Background to *Basis of Safety*

Findings from Audits and Incident Investigations invariably include some or all of the following elements:

- absence or lack of safety control documentation for activities
- insufficient evaluation of risks / implementation of controls
- operating personnel not aware of or trained in *Good Explosives Practice*
- attention to detail lacking
- absence of safe systems of work and control measures
- poor line management and systems for auditing and inspection of operational activities
- complacency

To summarise:

The *Basis of Safety* for the operation or activity was being compromised



BASIS OF SAFETY

Background to *Basis of Safety*

Basis of Safety was introduced as an extension to and incorporating *Good Explosives Practice* across ICI Explosives businesses for a range of explosives operations. Initially 15 separate process covered:

- Manufacture of Detonating Cord
- Commercial Detonator Delay Composition / Delay elements
- Manufacture of Emulsion Explosives
- Manufacture of Primary Explosives
- Detonator Loading
- Shock Tube Detonator Assembly
- Blackpowder and Safety Fuse
- PETN Manufacture
- Manufacture of Cast Pentolite Primers
- Shock Tube Manufacture
- Explosives Testing
- Manufacture of NG / NG Explosives
- Charging of Blast Holes
- Explosives Magazines
- Manufacture of ANFO Explosives



BASIS OF SAFETY

Background to *Basis of Safety*

Following recent endorsement by the Orica Explosives Group Management Team accountability for the Basis of Safety process and the identification of process experts has been established.

Five new Processes have also been identified for addition to the initial list of operations. These are:

- Safety on Customer Sites
- Fusehead Manufacture
- Rigid Delay Element Manufacture
- Electronics
- Underground Bulk Applications
- Ammonium Nitrate Manufacture



BASIS OF SAFETY

GOOD EXPLOSIVES PRACTICE

Dealing with explosives in a manner that confirms:

- Knowledge of the hazards
- Respect for the hazards
- Plant / Process design to avoid ignition
- Protection provided to minimise the effects of ignition
- Implementation of *Basis of Safety* principles



BASIS OF SAFETY

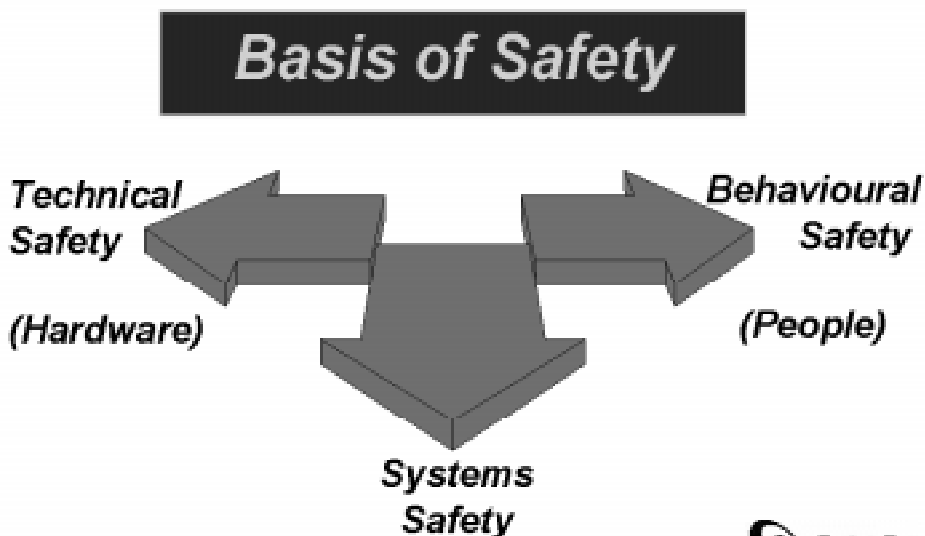
Why Basis of Safety ?

- aimed at preventing significant incidents - fire, explosion, loss of containment etc.
- provides a simple process which is applied to major risk operations only and has a short list of hazard categories
- applied separately to each process/technology
- encompasses scientific/engineering principles and learning from past incidents

Basis of Safety is the prime vehicle for ensuring
... **CORPORATE MEMORY**

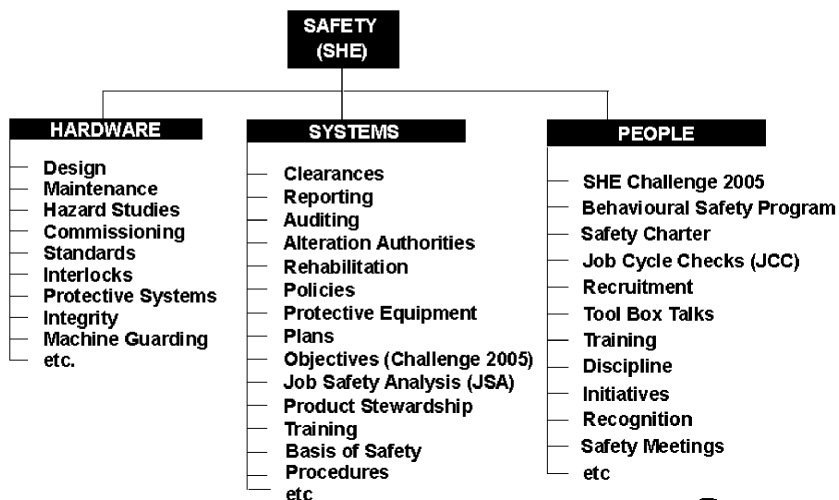


BASIS OF SAFETY



BASIS OF SAFETY

Examples of what we mean by Hardware, Systems & People are incorporated in our SH&E Management Standards and Procedures:



BASIS OF SAFETY

WHAT IS *BASIS OF SAFETY* ?

The Explosives *Basis of Safety* for a person, piece of equipment or process is the set of controls that is in place to eliminate the hazard or minimise the risks associated with the hazard, in a specific operation or activity.

It looks at : *Effect*
Cause
Control

It is NOT : Inherent SH&E
Hazard Study
Plant Dossier
Operating Instructions



BASIS OF SAFETY

WHAT IS *BASIS OF SAFETY* ?

BULK & PACKAGED EMULSION OPERATIONS

Example of Basis of Safety issue.

- Effect:* *Fire & Explosion*
- Cause:* *Poor materials control resulting in
incompatible materials being mixed
(eg. in a Depot/on a Plant/on a Truck)*
- Control:* *Basic awareness and understanding of
the hazards
Clear operational procedures that are
known and fully understood
Segregation of materials (this is the key
element) - not forgetting waste!
Regular workplace inspections/audits*



BASIS OF SAFETY

Examples of *Basis of Safety* being compromised:

Blackpowder Manufacture / Handling

- mound inadequate to protect control room
- licence limits exceeded in building
- transport 'bogies' poorly maintained
- lack of explosives awareness of operators
- nuts / bolts not secured
- changes in materials of construction

Propellant Manufacture

- permitting system not operating correctly
- poor control of maintenance activities
- nuts / bolts not secured over equipment
- no covering over open hoppers
- metal detection not operational / bypassed



BASIS OF SAFETY

Basis of Safety Objectives

To Promote Human Factors in Safety through:

- **Visible Line Management Commitment**
- **A Climate which Promotes Commitment to Safety**
- **Monitoring of Procedures and Performance**
- **A Climate of No Deviation without Agreement**
- **Excellent Communication Systems and Skills**
- **Excellent Training Systems**



BASIS OF SAFETY

Basis of Safety Objectives

To ensure that:

- **Every employee involved in Manufacturing, research, distribution and handling of Explosives and initiating systems understands and behaves in line with the Basis of Safety for the technology involved**
- **No new employee or re-positioned employee is exposed to the hazards associated with any activity without being educated fully to the same level of understanding and knowledge**



BASIS OF SAFETY

How is *Basis of Safety* applied in practice ?

In relation to these 3 key components of Corporate Memory - Hardware, Systems and People - the assessment of particular elements of a process or operation should address the following:

- Operation Characteristics
- Issues
- Known Incidents
- Safety Systems (Control Measures)
- Role of Individual
- Activity



BASIS OF SAFETY

What are the Next Steps ?

(1) Operation Characteristics

Identify the key elements of the process operation and the main hazards / risks

For example:

- Raw Materials - transport, storage, handling, use etc.
- Processing - pumping, charging, reaction, blending, mixing, drying etc.
- Final Products- handling, transport, storage, use, disposal etc.
- Waste Management - recycling, treatment, disposal etc.



BASIS OF SAFETY

(2) ISSUES - sources of ignition / aggravating circumstances

For each process, identify the main sources of ignition (internally and externally) associated with the operation or activity, for example:

- © FRICTION
- © IMPACT
- © STATIC
- © HEAT
- © YOU

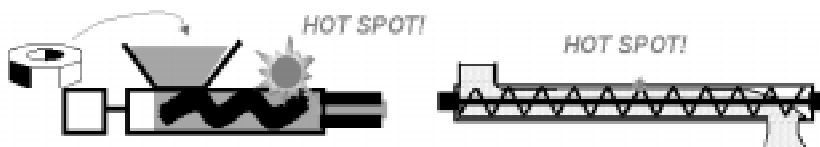


BASIS OF SAFETY

FRICTION

Examples:

- worn or distorted fixed moving parts of equipment,
- ingress of grit, foreign objects etc. to process,
- ingress of materials into bearings and joints,
- broken equipment parts getting trapped in moving parts
- dry running of pumps



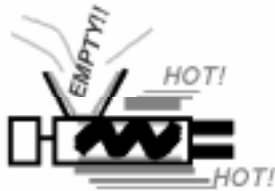
Heat from friction caused by foreign objects, poor clearance or flexing.



BASIS OF SAFETY

FRICTION

Examples:



When DRY RUNNING of an emulsion pump occurs the sequence of events is as follows:

1. Suction side of pump is empty
2. Product is heated by the stator/ rotor or piston friction
3. Residue/product loses water
4. Pump stator heats & decomposes
5. Exothermic reaction or fire occurs
6. Thermal explosion may occur with possible loss of containment

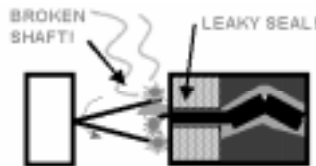


BASIS OF SAFETY

IMPACT

Examples:

- broken shaft on pump, stirrer etc.
- Rough handling, dropping - collision with hard surfaces
- use of excessive force / wrong tools (eg.maintenance)
- sensitisation caused by ingress of grit or contaminant
- mechanical failure/shearing of equipment that subsequently falls from height



Impact caused by catastrophic failure of a pump, pump parts or leaky seal.

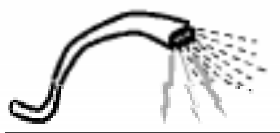


BASIS OF SAFETY

STATIC (electrostatic discharge)

Examples:

- incorrect clothing / footwear
- incorrect materials used for receptacles / packaging
- inadequate earthing (flooring / bonding systems)
- low humidity



Discharge of static electricity
when pumping dry products
eg., blow loading ANFO.



BASIS OF SAFETY

HEAT

Examples:

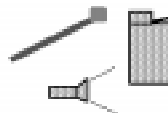
- carrying out 'Hot work'
- mixing incompatible chemicals / materials - exotherm
- exposed hot surfaces - heating, pipework, lighting
- chemical reaction - loss of control
- excessive process temperature - trip/alarm failure
- dead heading / dry running of process pumps



Reactions between residual
chemicals and heat.



Grinding steel, augers,
pumps, pipes, plates, bolts



Any activity or equipment that may
introduce a source of ignition.



BASIS OF SAFETY

HEAT

Examples:



When **DEAD HEADING** of an emulsion pump occurs the sequence of events is as follows:

1. Product is contained - outlet is closed
2. All drive energy is put into the contained product
3. Temperature increases
4. Pressure increases
5. Water evaporates from the emulsion
6. The emulsion becomes more viscous
7. Endothermic ammonium nitrate dissociation begins
8. Thermal explosion of pump contents begins as exothermic reaction starts



BASIS OF SAFETY

YOU (human element)

Examples:

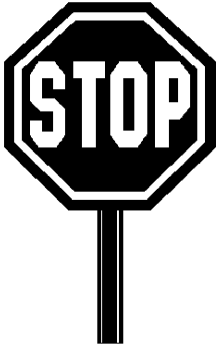
- poor training and awareness of hazards
- unsafe practices / non adherence to operating procedures
- use of wrong tools / equipment for the job
- poor housekeeping practices
- non compliance with licences
- unauthorised changes to process, plant, equipment, materials etc.



BASIS OF SAFETY

YOU (human element)

Use Total Observation Skills



- **LOOK** - Above / Below / Behind / Inside (ABBI)
- **LISTEN** - for unusual sounds
- **SMELL** - for unusual odours
- **FEEL** - for unusual temperatures and vibrations

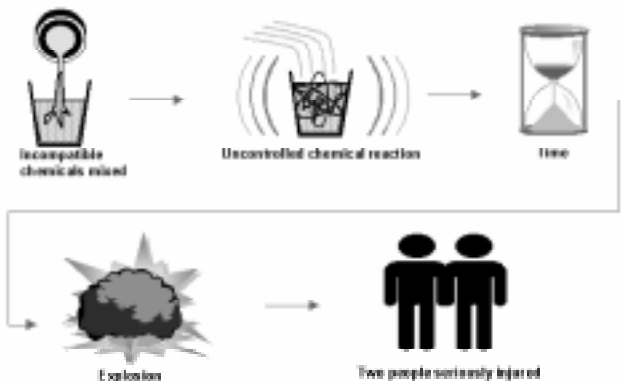


BASIS OF SAFETY

(3) KNOWN INCIDENTS

Be aware of and use learning from previous incidents

Example: Mixing chemicals - Heat / Explosion



Argyle Australia 1995 - detonation of waste due to mixing of incompatible chemicals (gassing' chemicals with Ammonium Nitrate and Emulsion Matrix).



BASIS OF SAFETY

(3) KNOWN INCIDENTS

Example: Friction/Heat - Thermal Explosion



Finished product thermal explosion/
detonation - Sasol/China/Porgera
(multiple fatalities).



Oxidiser pump thermal explosion
- Canada.



Contaminated emulsion thermal explosion/
detonation - Russia (multiple fatalities).



BASIS OF SAFETY

(3) KNOWN INCIDENTS

Examples of more recent incidents:

- **May 2000 - Fire and Explosion involving Fireworks (Holland): 20 Fatalities**
Cause: 90% of the fireworks in storage were actually of higher hazard classification than the permit allowed
Fire-prevention provisions were insufficient. As a result of this, an initial small fire in the storage area next to a residential area was able to escalate into a mass explosion
- **Feb 2001 - Explosion in PETN granulation Plant (South Africa): 1 Injury**
Cause: Permit to Work issued for repair to granulator flange but incorrect procedure used to decontaminate. Accountability for this was unclear
Recommendation: Decontamination procedure and PTW review / clarify accountability for decontamination
- **Mar 2001 - Explosion of explosives/detonators (India): 15 Fatalities (at least)**
Cause: Accidental fire during unloading from truck
- **Aug 2001 - Explosion of Lead Styphnate (Czech Republic): 1 Fatality**
Possible cause: Deviation from correct procedure
Recommendation: Refresher training / minor procedural changes



BASIS OF SAFETY

(4) CONTROL MEASURES

Some examples:

- Ensure all personnel fully trained / aware of and understand all hazards
- Consider plant design/layout and requirement for remote operation
- Carry out hazard study / risk assessment and follow through actions
- Ensure equipment fitted with safety devices where appropriate
- Register and maintain all critical items of plant and equipment
- Tag, label critical items of equipment / process lines / valves etc.
- Clearly define all critical process parameters - ensure limits set
- Ensure all movable items secured, particularly above vessels, hoppers etc.
- Eliminate possibility of ingress of grit/contaminants - cover all open vessels
- Define clearly hazards associated with non compatibility of materials
- Use only tools defined for the job
- Ensure only appropriate clothing and footwear used
- Establish good housekeeping practices
- Ensure appropriate safety systems in place
- Carry out regular safety auditsetc. etc.



BASIS OF SAFETY

(4) CONTROL MEASURES - SAFETY SYSTEMS

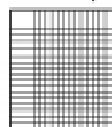


Operational Procedures



Material safety data sheets, chemical inventories, safe handling guides

Material/chemical compatibility matrix



Hazard studies



Alteration Authorities



Permit to Work / Hot Work on process related equipment must be done under authorised clearance



SHE Audits



BASIS OF SAFETY

(5) ROLE OF INDIVIDUAL

Examples:



Always follow operating / maintenance procedures and obey site rules



Always report any unusual occurrences



Treat all explosives particularly initiating explosives with respect



Always clearly label any waste or chemical not in its original packaging (no part bags on site).



Know the **EMERGENCY** procedures



BASIS OF SAFETY

(6) ACTIVITY

Training

- Establish program to ensure training / validation of all personnel in the Basis of Safety for the operation / activity
- Carry out annual refresher training

Audits

- Carry out workplace / site audits (eg. World Class audits)
- Read through / review Audit Reports and findings with personnel and ensure system to record and close-out corrective and preventative actions

Toolbox Talks

- Discuss any recent incidents or stories that operators may have
- Communicate all SHE Alerts / Engineering 'Snippets'



BASIS OF SAFETY

EXAMPLE OF BASIS OF SAFETY MATRIX FOR BULK EMULSION OPERATIONS

This Basis of Safety matrix document addresses the prevention of major incidents. (Explosion, fires, violent decompositions or pressure venting, toxic fumes, chemical burns and major injuries)

ELEMENT	ISSUES	SITUATIONS	KNOWN	SAFETY	YOUR ROLE
HOT WORK	Reaction of or between residual chemicals due to heat or flame	Hot work on concealed spaces (cracks, plates etc) in Augers, Valves, Bins, Tanks, Pipes, Chassis of MMU's, ELK's etc.	Magazine exploded after fire caused by residual welding heat	Clearance system (includes Hot Work data sheets and 2nd level sign off, stand by man).	Only conduct hot work under a Clearance - Do only work specified on clearance
PUMPS					
MOVING PARTS					
CHEMICALS					
BULK STORES					
ON BENCH					



BASIS OF SAFETY

CONCLUSION

- S **Identifies and documents SHE process requirement**
- S **Is aimed at prevention of catastrophes - not minor incidents**
- S **Increases understanding of hazards at all levels (operators, engineers, technical)**
- S **Can be applied to any process / operation**

