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Process Safety Beacon

Messages for Manufacturing Personnel

March 2002

LAYERS OF PROTECTION
You NEED Them

HERE'S WHAT HAPPENED……

During a non-routine procedure, materials were transferred into a vessel. A number of items were present (i.e., "layers of protection") to prevent vessel damage, including:

- A high pressure alarm (in this case, the alarm was acknowledged earlier when it was assumed to be caused by a faulty instrument)
- A pressure control system which allows pressure to be vented to another system in the area (in this case, this "second system" was out of service), and
- A pressure relief/vacuum system which vented to the atmosphere (this system contained a flame arrestor which was found to be plugged).
- The net result of all these failures was a ruptured roof on the tank

What do layers of protection accomplish?

- A well designed facility includes multiple items of protection for equipment;
- These frequently include a number of the following: operator monitoring, procedures, alarms, interlocks, pressure rated equipment and relief/vacuum valves, and
- In most cases, multiple systems must fail before vessel damage occurs

What can I do to protect equipment?

- **NEVER** assume an alarm is functioning improperly -if an alarm becomes a nuisance, take immediate steps to have it repaired;
- Review alarm status for equipment early in your shift, understand why **ALL** alarms are present;
- Pressure/vacuum relief valves are often the **LAST** line of defense which prevents vessel damage, maintenance systems must be in place to properly test these devices;
- Pluggage in vent lines must be managed - if a line has a tendency to plug, cleaning frequencies should be adjusted to maintain the line in a "clean" state; and
- Non-routine operations often have fewer or weaker layers of protection when compared with "routine" operations, all items preventing equipment damage are especially critical.

Contact us at ccps@aiche.org or 212-591-7319.

CCPS CENTER FOR CHEMICAL PROCESS SAFETY 20 YEARS
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Process Safety Beacon

http: //www.aiche.org/ccps/safetybeacon.htm

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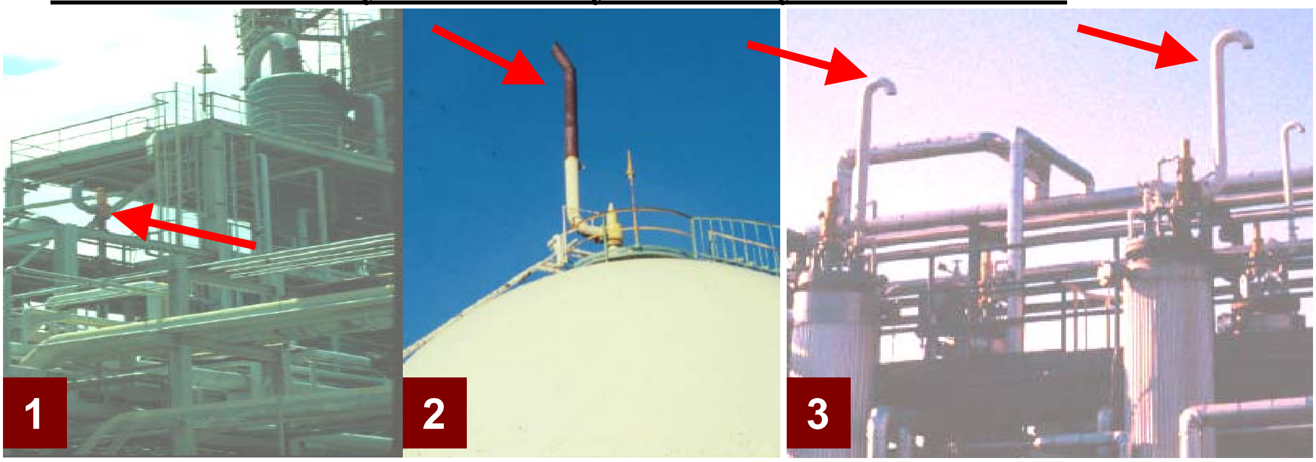
Pressure Relief Systems – Do you see any hazards here?

March 2006



YES there are!

1 The discharge from the relief valve in picture #1 is directed toward a personnel access platform above. If the relief valve opens while someone is working on the platform, that person would be exposed to the discharged material and possibly injured.

2 The relief valve discharge in picture #2 is through a **long, unsupported** pipe. The force generated by the material flow could bend, break or restrict the discharge pipe, any of which could lead to personnel exposure or a failure of the system to operate as intended.

3 The discharge from the relief valves in picture #3 is directed downward, toward an area where people could be working. As in the first picture, anyone working in this area when a relief valve opens could be injured. The discharge pipes are also long and unsupported as in picture #2.

These pictures illustrate hazards found in many plants which handle chemicals. Relief devices often discharge to a 'convenient' location - and that may not be the same as a 'safe' location!

What You Can Do

- Relief valves and rupture disks are part of an emergency pressure relief ***system***. Its design must not only prevent equipment overpressure, it must also make certain that material discharged does not lead to personnel injury. The system needs to ensure that there is no fire, explosion, or toxic material exposure hazard from the material released through a relief valve or rupture disk.
- Plant modifications include new platforms, vessels, piping and a variety of other additions. Potential exposure to effluent from existing AND new pressure relief devices must be included in your management of change process.
- Drain, vent and sample valves from equipment or piping as well as vessel overflows can have similar hazards. Any material which could be released from process equipment, including pressure relief valves or rupture disks, must discharge to a safe location.
- ANY open pipe has the potential for an unexpected discharge. The release could occur for a variety of reasons and it will often be a surprise. Use extra caution when working around them - expect the unexpected!

ANY open pipe is a potential chemical discharge!

The Beacon is usually available in Arabic, Chinese, Dutch, English, French, German, Hebrew, Hindi, Italian, Korean, Portuguese, and Spanish

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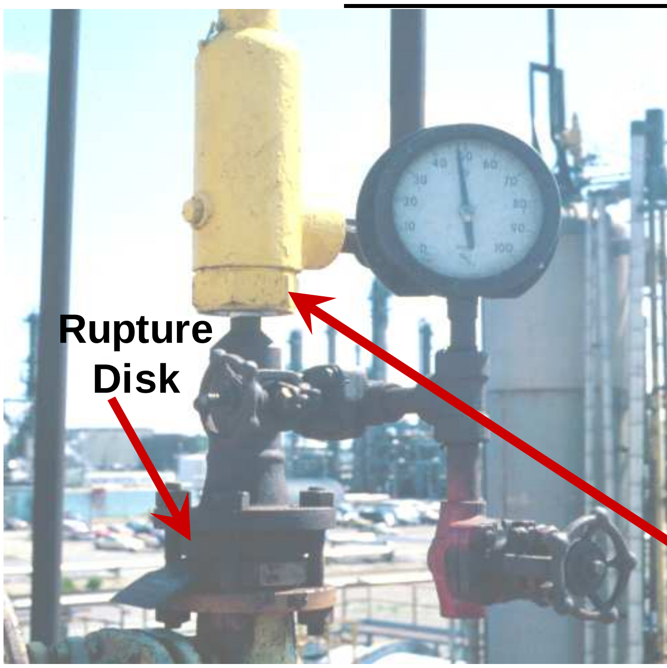
November 2006

Hazards of Relief Devices in Series



A vessel has a rupture disk and a pressure relief valve in series to protect against high pressure in the vessel. There is a pressure gage on the pipe between the rupture disk and the relief valve. As a part of your regular plant inspection, you are supposed to check the pressure gage. The gage normally reads zero. Today you observe a pressure of nearly 50 psig (~3.5 barg) as shown.

Do you understand why this is a significant hazard? How does pressure between the rupture disk and the pressure relief valve affect the performance of the vessel overpressure protection system?

Did you know?

- A rupture disk bursts when the pressure on the process side of the disk exceeds the pressure on the downstream side by the design pressure of the rupture disk. So, a 100 psi (6.9 bar) rupture disk will burst when the pressure on the process side of the disk is 100 psi (6.9 bar) greater than the pressure downstream of the disk.
- The pressure might be caused by a small "pinhole" leak in the rupture disk which will allow material to slowly leak through the disk and build up pressure, or it could be the result of a burst rupture disk.
- Because there is nearly 50 psig (3.5 barg) pressure on the downstream side of this rupture disk, if the pressure was caused by a pinhole leak, the rupture disc will not burst until the pressure in the vessel is equal to the rupture disk design pressure plus 50 psi (3.5 bar). If this is a 100 psi disk, it will not burst until the vessel pressure is nearly 150 psig (~10.3 barg). This might result in failure of other equipment attached to the vessel - perhaps a sight glass, a hose, or a gasket which cannot withstand the higher pressure.

What can you do?

- Check to ensure that your training program covers this situation.
- Do you know what to look for to recognize a rupture disk and relief valve in series?
- If you have installations like this, be sure to check the pressure regularly.
- If you observe pressure between a relief valve and a rupture disk, be sure to investigate and correct the problem as soon as possible.
- Make sure you understand the reason for ***all*** process data that you are asked to observe and record, know when an observed reading warns of a hazardous situation, and know what action to take to correct the problem.

CCPS PSID Members, see Free Search--Relief Valves

Don't just write down the data – understand what it means!

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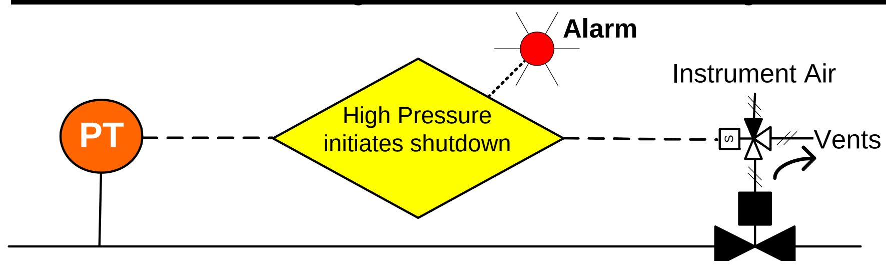
What is a Safety Instrumented System?

July 2009



Pressure (Field Sensors) | **Pressure ≥ 100 psi** (Logic Solver) | **Valve is closed** (Final Elements)

A safety instrumented system (SIS) takes automated action to keep a plant in a safe state, or to put it into a safe state, when abnormal conditions are present. The SIS may implement a single function or multiple functions to protect against various process hazards in your plant. There are many other names that you may use for this kind of a system, for example, safety shutdown system, emergency shutdown system, safety interlock, protective instrumented system, or safety critical system. In most cases, each function in an SIS consists of three components, as shown in the drawing above:

- a sensor which monitors the process to detect an upset or abnormal condition (for example, a pressure sensor)
- a logic device which receives the signal from the sensor, determines if the condition is hazardous, and, if so, sends a signal to take action
- a final control device, which receives the signal from the logic device and implements the appropriate action in the plant (for example, opening or closing a valve, shutting down a pump)

SISs are designed at different safety integrity levels (SILs) based on the risk posed by the process hazard. The higher the SIL, the more likely there will be multiple, redundant components (for example, more than one sensor, logic solver, or final element) and more rigorous testing and management requirements.

Do you know?

- Safety systems, such as an SIS, are covered by a design basis and a mechanical integrity (MI) program.
- SIS MI includes procedures for inspection, preventive maintenance, proof test, and repair.
- MI frequency is specified to ensure that the SIS is as reliable as required by the plant designer.
- MI relies on knowledgeable people who follow rigorous work practices to determine the condition of the SIS equipment.
- When an SIS is activated, you should know what actions to take, such as emergency response activities.

What can you do?

- Understand the causes and consequences of abnormal operation in your plant.
- Know if you have an SIS in your plant, how it works, what conditions cause it to act, what it does, and what you must do if the SIS activates.
- Know where to find the documentation for the SISs in your plant.
- Make certain that SISs are properly inspected and tested so they remain in good working condition.
- Notify your supervisor if an SIS is not working properly, and follow your plant procedures to maintain safe operation while repair is completed.

Know how the Safety Instrumented Systems in your plant work!

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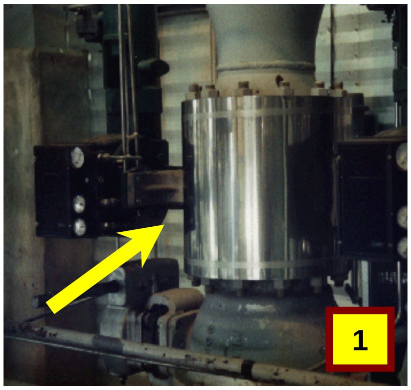
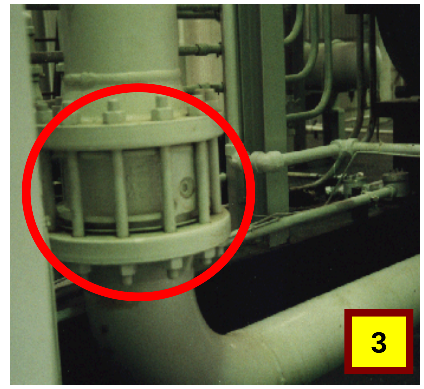
Fire Protection - Long Bolt Flangeless Valves

April 2010

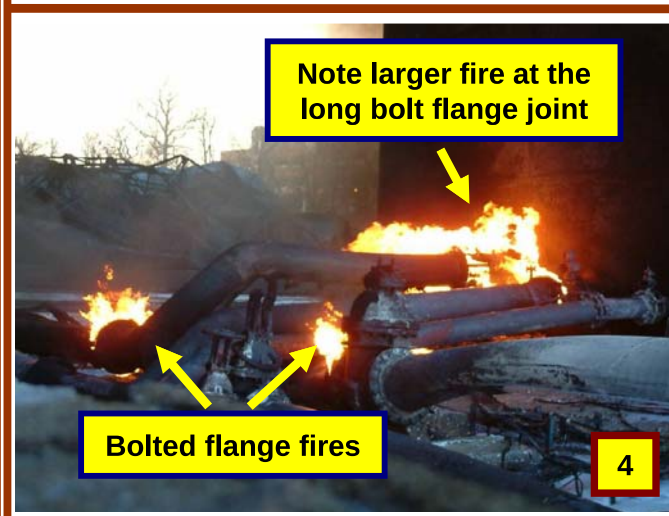




Would you recognize the metal cover (yellow arrow) in Picture 1 as an important piece of safety equipment? If it was damaged or missing, would you know to report it so that it could be repaired or replaced?

The metal cover wraps something called a "long bolt flangeless valve" (also called long bolt, sandwich, flangeless, or wafer valves). Some examples, with the covers removed, are circled in red in Pictures 2 and 3. These valves have no integral flanges for bolting to pipe or vessel flanges, and have exposed bolts longer than 3 inches (about 7 cm.). If there is a fire in the area, the long bolts may be contacted directly by flames (impingement). The heat causes the bolts to expand and lengthen, allowing the gaskets on the two sides of the valve to leak. If the leaking material is flammable or combustible, it will add fuel to the fire (Picture 4). If the pipe is under pressure, a large, spraying fire that results in more damage can occur.

The metal cover wraps the long bolts with a fire resistant material and encloses the entire assembly with a stainless steel covering to protect it from flame and heat impingement. It is an important safety device. It must be properly re-installed if removed for maintenance. It must also be inspected periodically to be sure it is in good condition, and any damage must be reported so it can be repaired.



What can you do?

- If you have long bolt flangeless valves on piping in combustible, flammable or LPG service, make sure the covers are properly maintained at all times.
- A cover on a long bolt flangeless valve can hide corrosion or other damage. The covers should be removed periodically to inspect the flanges and valves under the cover, and immediately replaced following the inspection.
- Passive fire protection on such a valve will only be rated for a short duration fire, and an inherently safer engineered solution would be to replace the flangeless valve with a fully flanged valve.

Understand your Safety Equipment!

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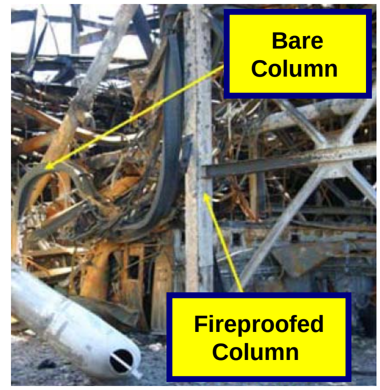
Fireproofing Structural Supports

May 2010



The April 2010 Beacon discussed the use of fireproofing to protect process piping components, specifically long bolt flangeless valves. Fireproofing is a fire resistant insulating material which is also often applied to the surface of structural steel to delay heating of that steel from fire exposure. The primary purpose is to improve the capability of structural steel to maintain its integrity until the fire is either extinguished or other active fire protection systems can provide adequate cooling protection. Without fireproofing, exposed structural steel, such as the pipe rack support columns in the photograph at left, or the support columns in the photograph on the right, can rapidly lose strength and fail, possibly within minutes. The failure of the piping and equipment supports can break pipes or cause vessels to fail, releasing more flammable material, and causing a larger fire.

← Some examples of damage to fireproofing on steel pipe bridge supports – the fireproofing has been removed, or has become degraded and fallen off.

What can you do?

- As you go about your work, look for damage to fireproofing on support columns or beams for pipe bridges, buildings, outdoor process equipment structures, and other equipment supports.
- Periodically include inspection of fireproofing as a part of your routine plant safety inspections.
- Report observed damage and make sure that it is repaired.
- If you are doing any work that requires temporary removal of fireproofing on structural elements, make sure that the fireproofing is replaced when the job is finished.
- If you damage any fireproofing on structural elements in the course of other work, report the damage and make sure it is repaired.
- Be aware that damaged fireproofing can also allow the entry of water which can further damage the fireproofing and corrode the steel under the fireproofing.

Take care of fireproofed structural steel so it can take care of you!

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Containment Dikes and Pads

June 2010

Most people recognize that containment dikes around storage tanks, and sloped containment pads for pumps, process buildings and structures, truck and rail car unloading areas, and other potential spill locations have an important environmental protection function – preventing contamination of soil and surface water. But, do you know that they often also have important safety functions? Some examples include:

- limiting the spread of a fire and preventing exposure of other equipment if a flammable material spills and is ignited
- preventing contact of incompatible reactive materials in case of leak or spill
- limiting the spread of spilled corrosive material and preventing contact with equipment which could be damaged by contact with the corrosive material

In 2001, the US Chemical Safety and Hazard Investigation Board (CSB) investigated a fire that destroyed a petroleum blending facility in Texas. Poor dike design and maintenance resulted in burning liquid spreading the fire from tank to tank, eventually engulfing the whole plant.

←Spill containment dikes for chemical storage tanks

A sloped containment pad directs any spills from a truck unloading facility to a chemical sewer trench →

What can you do?

- Periodically include containment dikes around storage tanks, sloped containment areas, and drainage trenches as part of your routine plant safety inspections. Look for physical damage, spilled material, accumulation of rain water in dikes, or blocked drainage. Look for debris, equipment, or anything which restricts flow of a spill.
- Make sure that your plant procedures include pumping out or draining rain water from containment dikes – if a dike is partly filled with rain water, it may not be able to contain a large spill.
- If you have any kind of valves or other piping to remove rain water from a containment dike, make sure these are closed or otherwise blocked when not being used.
- If you do any maintenance or construction work on a storage dike which results in damage to the integrity of the dike, make sure the damage is repaired before the job is finished.

The arrow shows a hole in a containment dike. More damage can be seen at the base and the top of the dike wall. Other examples of damage include cracks in dike walls or floors, holes where pipes have been installed passing through dike walls, and anything else which would allow spilled material to flow out of the dike area.

Inspect and maintain your containment dikes and pads!

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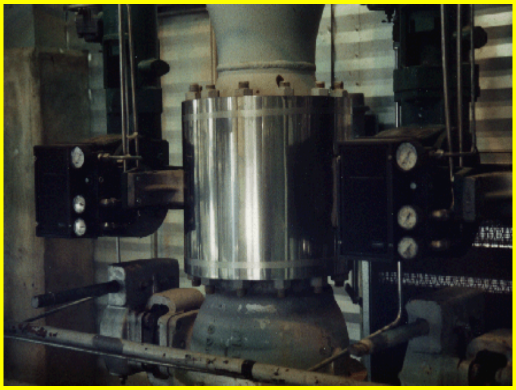
Passive Safety Equipment

July 2010



April – Insulating cover on a long bolt flangeless valve

May – damaged fireproofing on a pipe bridge support column

June – a hole in the wall of a tank farm containment dike

Can you figure out what the April, May, and June 2010 issues of the *Process Safety Beacon* have in common? All of them discuss a type of safety equipment that can generally be described as ***passive***. Passive safety devices do not have to detect an unsafe condition or take any action to perform their protective safety function. They have no sensors or moving parts. They do their job because of their construction – for example, the insulating characteristics and thickness of insulation or fireproofing, or the height and impervious material of construction of a dike wall.

Here are some other examples of passive safety equipment which you might have in your plant: containment buildings for toxic materials, blast resistant control rooms or other buildings, blast resistant buildings for storage of potentially unstable materials such as organic peroxides, flame or detonation arrestors, insulation on storage tanks to limit heat exposure to a fire (standards for sizing relief valves for preventing overpressure of a storage tank engulfed in a fire allow credit for insulation on the tank).

Did you know?

• Even though passive safety equipment does not have any sensors or moving parts, it does require ongoing inspection and maintenance. As shown in the previous three issues of the Beacon, insulation can be removed from equipment or it can deteriorate or be damaged; fireproofing can be damaged or removed; dike walls can have holes in them; and other types of passive safety equipment can deteriorate or be damaged.

• It is easy to forget about passive safety equipment, and to forget its importance for plant safety because it is just part of the plant background that you see as you go about your job, and you never notice its condition.

What can you do?

• Find out what kind of passive safety equipment you have in your plant, and understand what safety function it performs.

• Find out what must be done to maintain the passive safety equipment in your plant, and make sure these maintenance activities are done. Ask the people responsible for maintenance to explain the required maintenance.

• Learn how to recognize damage to the passive safety equipment in your plant so you can report it and have it repaired.

• Periodically include inspection of passive safety equipment in your plant safety inspections.

What passive safety equipment do you have in your plant?

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Process Safety Beacon — 10 Year Anniversary

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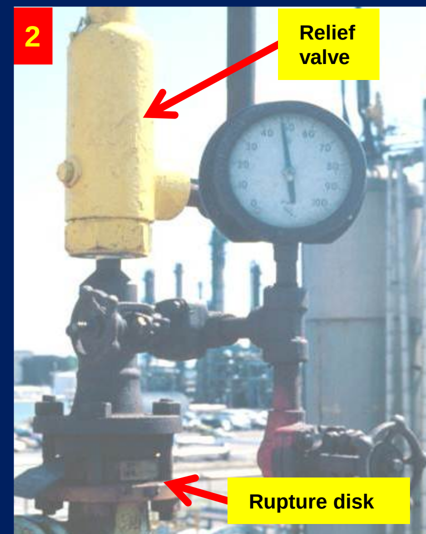
Messages for Manufacturing Personnel

Can you find the safety problem?

November 2012

We are finishing our celebration of 10 years of the *Process Safety Beacon* with a "Find the Problem" contest. Look at the pictures in this *Beacon* and identify as many hazardous situations (problems) as you can. There is at least one unique safety problem in Pictures 1 through 6, and Picture 7 has more than 10 (identify at least 6 to qualify as a contest winner). Not all are "process hazards" – you will find things like tripping hazards. We will select three winners at random from correct responses, and winners will receive a free CCPS book of their choice, subject to availability. Responses must be received by Midnight US Eastern Time on Nov. 30, 2012 to be eligible for the prizes.

Complete rules, and a form to submit answers, can be found at ***http://www.aiche.org/ccps/beaconcontest***. Our answers will appear in the January 2013 *Beacon*. You will also be asked to participate in a short survey to help us understand how the *Beacon* is being used, so we can better serve our readers. We realize that some of the pictures are small in this *Beacon*, so you will also find bigger pictures on line at the contest web address.



Always be alert and look for hazardous situations!

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10 YEAR ANNIVERSARY
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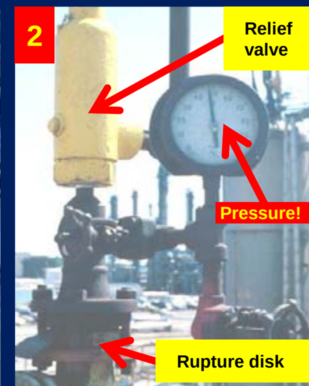
Some Answers to the November 2012 Beacon "Find the Problem" Contest

January 2013

First of all, thank you to everybody who participated in the November 2012 "Find the Problem" contest. We thank you for your interest, and, for those of you who also participated in the survey, for your valuable feedback on the Beacon. This Beacon needed to be prepared for publication and translation before all of the contest entries were submitted, so we were not able to include additional problems and hazards that have been undoubtedly identified by our tens of thousands of readers. Be assured that we were quite liberal in determining "correct" answers and accepted many other real problems beyond the ones listed here. Here are some of the issues we identified:

1. This is an easy one! Piping support is extremely poor!
2. The pressure between the rupture disk and the relief valve compromises the integrity of the emergency pressure relief system. Rupture disks burst when the difference between the upstream pressure and the downstream pressure exceeds the rupture pressure. If there is pressure downstream of the disk, it will not burst at the intended process pressure.
3. Despite the warning sign, the plug in the bonnet of this bellows sealed safety valve (which protects the valve during shipping) has not been removed. This will affect the pressure at which the valve opens.
4. Flexible hoses are being used to connect piping which does not fit together properly. Also, the flange on the right appears to be missing at least one bolt and the faces of the flange do not align properly.
5. All of these pumps are identical in appearance and there is no evidence of any labeling.
6. The valves and other pipe fittings on the inlet of the relief valve (RV) result in greater inlet pressure drop, which could cause relief valve chattering. The block valve on the RV inlet does not appear to have anything to prevent closing it and isolating the RV from the process.
7. There are many hazards in this photograph. Here are some of them, (you may find others!): (1) no visible label on the storage tank; (2) no eye wash or safety shower in the area; (3) the person in the picture is not wearing any personal protective equipment; (4) no chocks at tank truck wheels; (5) no visible spill containment; (6) many tripping hazards (and slipping hazards from the snow); (7) little or nothing to prevent backing the truck into the shed and unloading piping; (8) inadequate platform to access the unloading connection; (9) no way to drain the hose when unloading is complete; (10) no pressure gages anywhere on the unloading piping; (11) the valve handle downstream of the pump is too high; (12) the unloading piping is poorly supported.



Constant vigilance is the key to safety!

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A Safety Device Gone Wrong!

June 2014

Picture 1 shows a fire hydrant in a town in the northern USA that gets a lot of snow in the winter. The vertical steel rod fastened to the left side of the hydrant is intended to mark the location of the hydrant, as shown in Picture 2. A flag is installed at the top of the rod so firefighters can find the hydrant if it is covered with snow. The flag also marks the location of the hydrant so it is less likely to be damaged by snow removal equipment, and so people do not park vehicles where they will block access to the hydrant. The flag is a safety device to help people know where the hydrant is located if it is buried in snow.

Clearly this safety device has created a problem. The metal rod was installed so that it passes through the valve handle. You cannot open the valve without first removing the rod! The rod may also impede the use of a hydrant wrench to open the hydrant. While the rod and flag can be removed, this will take valuable time, possibly in an emergency situation.

Picture 1 resembles Picture 3, from the October 2004 *Beacon*. In Picture 3, nature, in the form of a growing tree branch, makes it difficult to operate the fire water valve. In Picture 1, somebody has installed a rod and flag through a fire hydrant valve, with the same effect.

Do you know?

➔ The flag on the fire hydrant can be considered to be a safety device – to protect the hydrant from damage by snow removal equipment, to remind people not to block access to the hydrant, and to help firefighters find the hydrant if it is buried by snow. But, because it was improperly installed, it is difficult to quickly open the hydrant valve. So, a safety device has created a new, and perhaps more serious, safety problem!

➔ Any safety device can create a new hazard. Any change to equipment, even one intended to improve safety, can create new hazards or make other existing hazards more severe. This is particularly true if the safety device is not properly installed.

What can you do?

➔ Any change to a system, including the addition of a new safety device, is a change that must be reviewed using your plant's Management of Change (MOC) procedure.

➔ When doing an MOC review of a new safety device, be sure to consider the possibility that the change introduces new hazards.

➔ After the change is reviewed, make sure it is implemented correctly and is ready for operation using your plant's pre-startup safety review (PSSR) process.

➔ Get emergency response personnel involved in MOC and PSSR if the change impacts them.

Review all changes – even those intended for safety!

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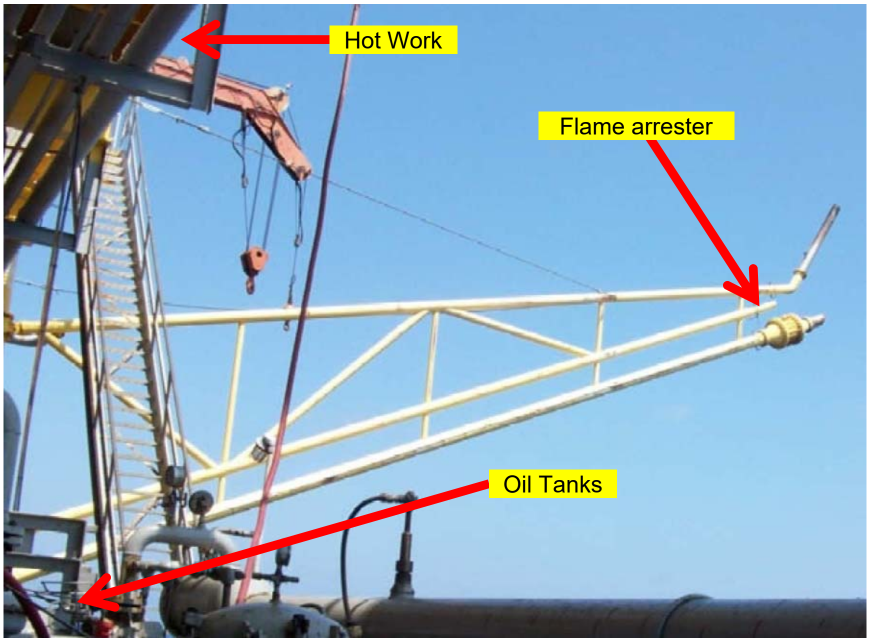
Plugged flame arrester causes explosion!

April 2016



Maintenance workers were doing hot work on an offshore platform, approximately 12 feet (3.7 m) above several oil storage tanks. There was an explosion which ruptured two oil tanks causing about $500,000 (US) damage and spilling approximately 1,200 US gallons (4.5 cu m) of oil into the sea.

The incident investigation found the following:

- The flame arrester on an oil tank was corroded and plugged with deposits. This resulted in the tank "breathing" through a sample hatch at the tank rather than through the flame arrester as intended. When it was hot, during the day, vapors would exit the tank through the hatch. Air would enter the tank through the hatch at night when it was cool.
- A sign on the flame arrester indicated that it should be "periodically serviced for safe operation."
- The flame arrrester was installed at the end of a flare boom and could not be easily accessed for inspection or maintenance.
- The oil tanks were not blanketed with inert gas, or protected from fire, sparks, or other potential ignition sources during the hot work. This was required by US regulations for offshore platforms because the hot work was near the oil tanks [30 CFR 250.113(a)].

REFERENCE: U.S. Department of the Interior, Bureau of Ocean Energy Management, Safety Alert No. 290, 14 October 2010.

What can you do?

- On land or water, flame arresters are important safety devices. Make sure that flame arresters in your plant are inspected and maintained as recommended by your plant engineers and the manufacturer.
- If a flame arrester or other important safety device is in a location where required inspection and maintenance is difficult or impossible, report the problem to your management so it can be corrected.
- Many regulations, industry guidelines, or company policies require a minimum distance between welding or hot work, or from a point where slag, sparks, or other burning materials could fall, and equipment containing flammable or combustible material. If moving equipment is impractical, the equipment must be protected with flame-proofed covers, inerted, or shielded with metal or fire resistant guards or curtains.

Flame arresters need inspection and maintenance!

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Process Safety Beacon

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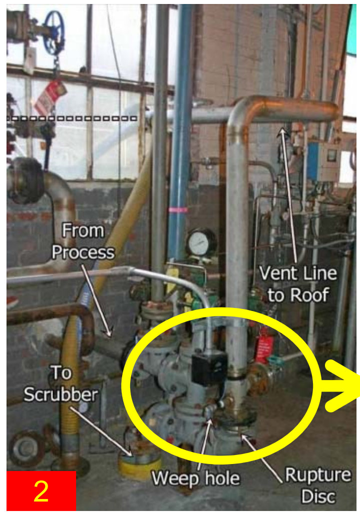
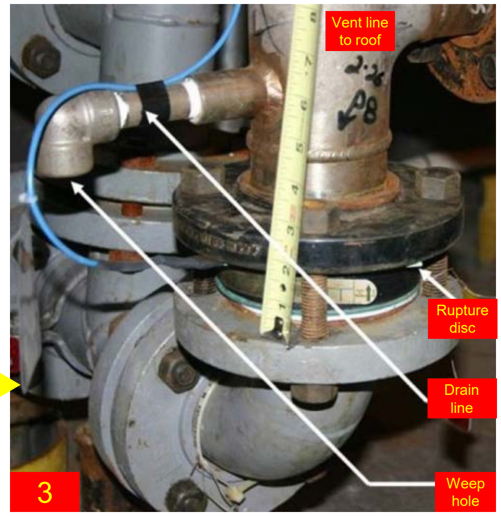
Messages for Manufacturing Personnel

Are your alarms alarming?

October 2017





Do you know Aesop's Fable "The Boy Who Cried Wolf"? A shepherd boy repeatedly tricked villagers by calling for help because a wolf was attacking the sheep, when there was no wolf. After a while, the villagers ignored the boy. One day there really was a wolf (1). When the boy cried for help, everybody assumed it was another false alarm. Nobody came, and the wolf had a sheep dinner. In some English versions of the fable from the 15th century, the wolf also ate the boy – perhaps an appropriate analogy for the potential consequences of ignoring alarms in the process industries!

Do you have alarms in your plant which are unreliable, frequently giving a "false alarm" because of faulty sensors or because they are set too close to normal operating conditions? Would you notice if one of these unreliable alarms warned of a real, important deviation which requires action? Or, do you have "nuisance alarms" which indicate minor process deviations which do not require any response? If you get a lot of these, you might fail to notice a "real" alarm!

The US Chemical Safety Board (CSB) investigated a 2010 incident at a plant in West Virginia in which an alarm was ignored resulting in a chemical release into a process building (2 and 3). A rupture disc on a reactor containing methyl chloride, a toxic and flammable gas, burst releasing methyl chloride to a vent line. The rupture disc was designed to provide an alarm when it burst, and this alarm worked. However, there was a history of false alarms, signaling a burst disc when it was actually intact. Operators were not aware that the device had been upgraded, and assumed it was another false alarm. There was a drain line with a weep hole on the vent, inside the process building. Methyl chloride was released through the hole into an area of the process building where people were not frequently present. The release went on for 5 days before a gas detector designed for another chemical was triggered. It is estimated that about 2000 pounds (900 kg) of methyl chloride was released.

What can you do?

- Never ignore safety alarms. Safety alarms should have specific response procedures, and you should always follow these procedures. Make sure you understand the response procedures and have been trained on them.
- If you have nuisance alarms, especially safety alarms, which "chatter" or remain in the alarm condition, report the problem to your instrument and automation engineers and management and work with them to fix the problem.
- If you have alarms that do not require a response, work with your engineers and management to eliminate them. Do not change alarm set points unless authorized.
- Make sure that any changes to alarm design and equipment, alarm set points, or alarm response procedures, are thoroughly reviewed using your plant management of change procedure. This includes informing all affected people about the change, and training on any modified procedures resulting from the change.

Don't ignore safety alarms – there might really be a "wolf"!

The Beacon is usually available in Afrikaans, Arabic, Catalan, Chinese, Czech, Danish, Dutch, English, Filipino, French, German, Greek, Gujarati, Hebrew, Hindi, Hungarian, Indonesian, Italian, Japanese, Korean, Malay, Marathi, Mongolian, Persian (Farsi), Polish, Portuguese, Romanian, Russian, Spanish, Swedish, Telugu, Thai, Turkish, and Vietnamese.

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Do not allow your relief device vents to be a hazard

March 2021

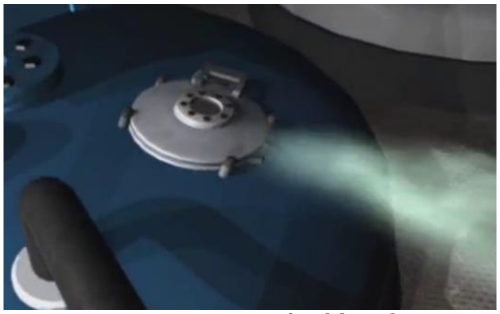

Figure 1. Process vapors leaking from manway

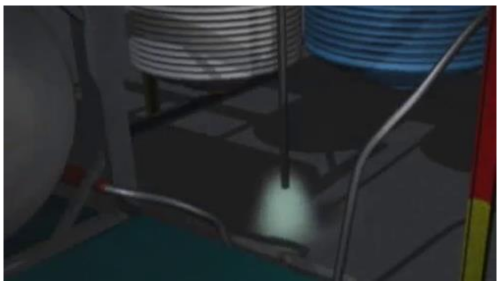

Figure 2. Process vapors released at a low level near the process area

On April 12, 2004, a company in Dalton Georgia, USA was contracted to make triallyl cyanurate. A runaway reaction occurred, and flammable and toxic allyl alcohol and allyl chloride were released to the atmosphere. Some material was released through a poorly sealed manway (Figure 1) and more through the rupture disc vent which discharged near the base of the reactor (Figure 2). The release forced the evacuation of over 200 families in the surrounding community.

One worker received chemical burns and 154 people including 15 emergency responders had to be decontaminated and treated for chemical exposure. (Sources: CSB report 2004-09-I-GA. Figures from the CSB video "Reactive Hazards")

Another company in the U.S. received a regulatory inspection. They were cited for not venting process relief valves to a safe location. While the vents discharged outdoors, the release point was directly over an exit from the process building. An employee exiting during a relief discharge could have walked right into a cloud of process materials.

Did You Know?

1. Relief devices, whether used in process or utility service need to vent to a safe location. That can vary by the material being relieved.
2. Poorly sealed manways can release hazardous materials and expose workers in the process area. The relief device should be the only release point for overpressure.
3. Potential emissions from relief devices should be known and documented as critical safety and environmental data.
4. The safe location for a relief discharge needs to be in an area where volatile materials can disperse to the atmosphere or where liquids can be contained.
5. When vented materials collect, they can result in a cloud of flammable or toxic materials that could ignite or expose worker or the community.
6. Changes to other processes or equipment in the area need to be reviewed for any impacts on the dispersion of relief emissions.

What Can You Do?

1. Search for relief device vents during your rounds in the unit. When you see one look for:
   a. Is it labelled as a relief line ?
   b. Could it expose someone?
   c. Is there other equipment around it that could trap flammable or toxic vapors?
   d. If the answer to any of these is "Yes" report it to your supervisor.
2. If there are process or relief vents at a low level that could expose someone, report these too.
3. Ensure all openings (manways, charge ports, etc.) on equipment and piping flanges are properly tightened, so systems vent only as designed.
4. During MOC reviews, ask for details of a relief discharge location. The relief location needs to allow dispersion of gases, vapors and/or capture of liquids.

Relief devices need to vent to a <u>safe</u> location. Verify that the locations are <u>actually safe</u>.

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How do you know your safety devices are working?

OCTOBER 2021

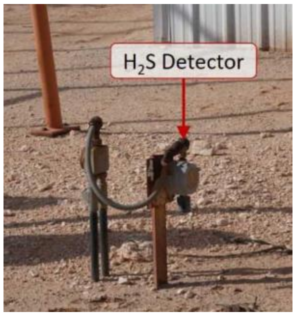


Fig. 1: One of the H_2S detectors

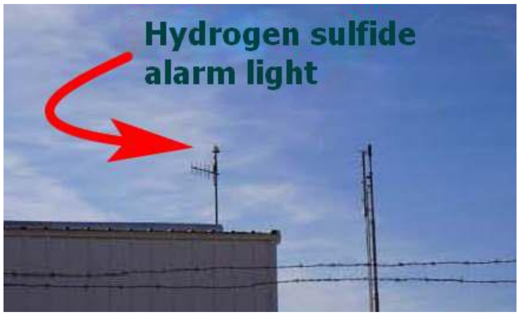
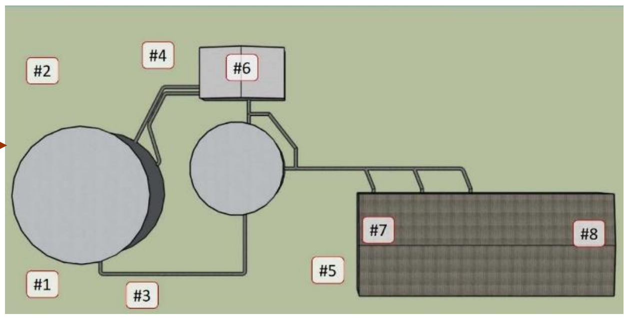


Fig. 2: H_2S alarm warning light

Fig. 3: H_2S detector location

(Figures 1-3 from US CSB report – see reference)



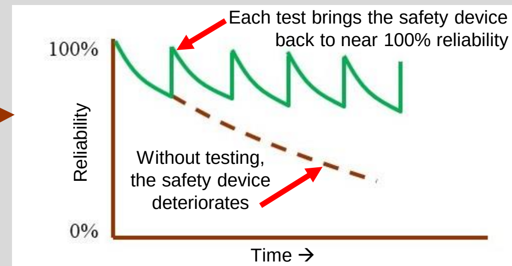
In October 2019, a lone-worker employee responded to a pump oil level alarm at an unmanned waterflood station in Texas. A waterflood station pumps water separated from crude oil back into the underground oil formation to improve extraction. The employee isolated the pump by closing valves but did not perform Lockout / Tagout. At some point, the pump automatically started, and water known to contain hydrogen sulfide (H_2S), a toxic gas, was released. The employee died from exposure to H_2S. The tragedy was compounded when the employee's wife searched for him and went into the waterflood station. She was also exposed to H_2S and died.

There were many failures in process safety management systems which contributed to this incident. This Beacon will focus on one of the contributing causes – the failure of the H_2S alarm system. The waterflood station was equipped with an H_2S detection and alarm system. However, the alarm panel did not receive a signal from the indoor or outside detectors (Fig. 1 and Fig. 3). Therefore, the H_2S alarm warning light (Fig. 2) was not activated. Some detectors were set in test mode, which prevented them from sending an alarm signal. Other detectors were correctly set up, but the signals were not received by the alarm panel. Investigators were unable to find any maintenance, testing, or calibration records for the H_2S detection and alarm system.

Did You Know?

- Active safety devices such as alarms, interlocks, or shutdown systems must be tested on a schedule, or reliability deteriorates over time (Fig. 4). This is particularly true of gas detectors which are sensitive instruments that require regular calibration.

Fig. 4: Safety device (H_2S alarm) reliability



- Most safety devices are not called on to function during normal operation of your plant. If they are not working because of component failure or an operational error such as disabling them, the failure is hidden.
- A robust reliability program tests all components as a system to confirm that the entire system will work when needed. Inspection, testing, and maintenance frequency and procedures are established by your plant engineers based on reliability calculations and failure data.
- Results of inspection, testing, and maintenance activities for safety devices must be documented.
- Test results should be reviewed to identify chronic failure issues, and to confirm that component failure rates are consistent with the designer's assumptions.

What Can You Do?

- If you are involved in inspecting and testing safety alarms, interlocks, and other safety devices, always follow procedures rigorously, and document the results.
- Use written checklists and procedures to ensure that required tests are properly done.
- Always remember to put the safety device back online when inspection and testing are complete.
- Know where to find the results of safety device tests. If you find that the required tests have not been done or documented, report your observations to management.
- If you are aware of safety devices that do not have inspection and testing programs, report this to management.

Reference: https://www.csb.gov/csb-releases-final-aghorn-investigation-report/

Inspect and test your safety systems to be sure they work!

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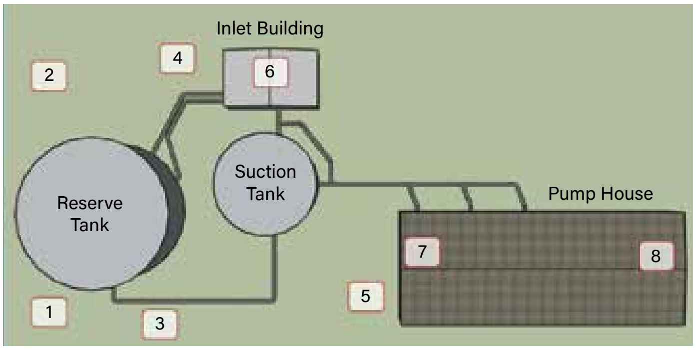
Are Your Safety Devices Working?

October 2021



▲ **Figure 1.** A waterflood station in Texas had a hydrogen sulfide (H_2S) gas detection and alarm system with eight H_2S gas detectors. However, the system failed, and two people were fatally exposed to toxic H_2S gas. Image courtesy of the U.S. Chemical Safety and Hazard Investigation Board.

On Oct. 26, 2019, a lone employee responded to a pump oil level alarm at an unmanned waterflood station in Odessa, TX. A waterflood station pumps water that is separated from crude oil back into the underground oil formation to improve extraction. The employee isolated the pump by closing valves but did not perform lockout/tagout. While the employee was still onsite, the pump automatically started, releasing water known to contain toxic hydrogen sulfide (H_2S) gas. The employee died from exposure to the gas. The tragedy was compounded when the employee's wife went into the waterflood station to search for her husband, and was also killed by H_2S exposure.

Many failures of process safety management (PSM) elements contributed to this incident. This Beacon focuses on one of the contributing causes: the failure of the H_2S alarm system. The waterflood station was equipped with an H_2S detection and alarm system. However, the alarm panel did not receive a signal from the indoor or outdoor detectors (Figure 1). Therefore, the H_2S alarm warning light was not activated. Some of the detectors were set to test mode, which prevented them from sending an alarm signal. Other detectors were correctly set up, but the alarm panel did not receive the signals. Investigators could not find any maintenance, testing, or calibration records for the H_2S detection and alarm system. Read the U.S. Chemical Safety and Hazard Investigation Board (CSB) Report No. 2020-01-I-TX for more information on this incident.

Did You Know?

- Active safety devices such as alarms, interlocks, or shutdown systems must be tested on a schedule, or their reliability will deteriorate over time. This is particularly true of gas detectors, which are sensitive instruments that require regular calibration.
- Some safety devices are not used during normal operation. It may not be apparent that a safety device has failed or has an operational error (*e.g.,* a worker disabled the device) if it is not used regularly.
- A robust reliability program tests all components as a system to confirm that the entire system will work when needed. Plant engineers establish inspection, testing, and maintenance frequencies and procedures based on reliability calculations and failure data.
- Results of inspection, testing, and maintenance activities for safety devices must be documented.
- Safety device test results should be reviewed to identify chronic failure issues and to confirm that component failure rates are as expected.

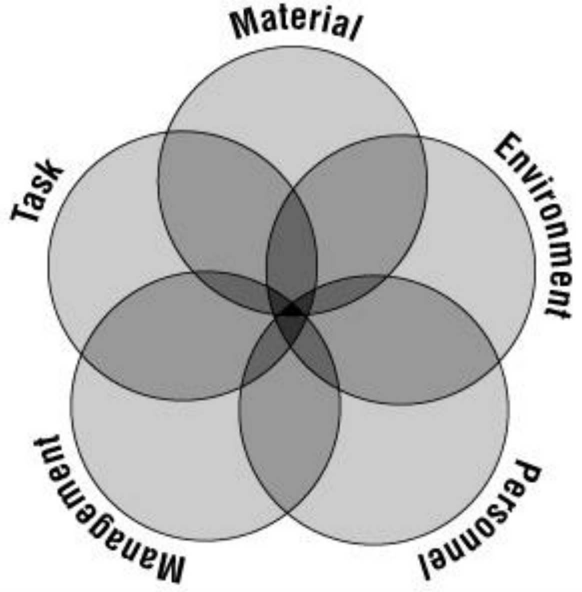
What Can You Do?

- If you are involved in inspecting and testing safety alarms, interlocks, and other safety devices, follow procedures rigorously and document the results.
- Use written checklists and procedures to ensure that tests are performed correctly.
- Be sure to put the safety device back online when inspection and testing are complete.
- Know where to find the results of safety device tests. If you find that the required tests have not been completed or documented, report your observations to management.
- Report any safety devices that do not have inspection and testing programs to management.

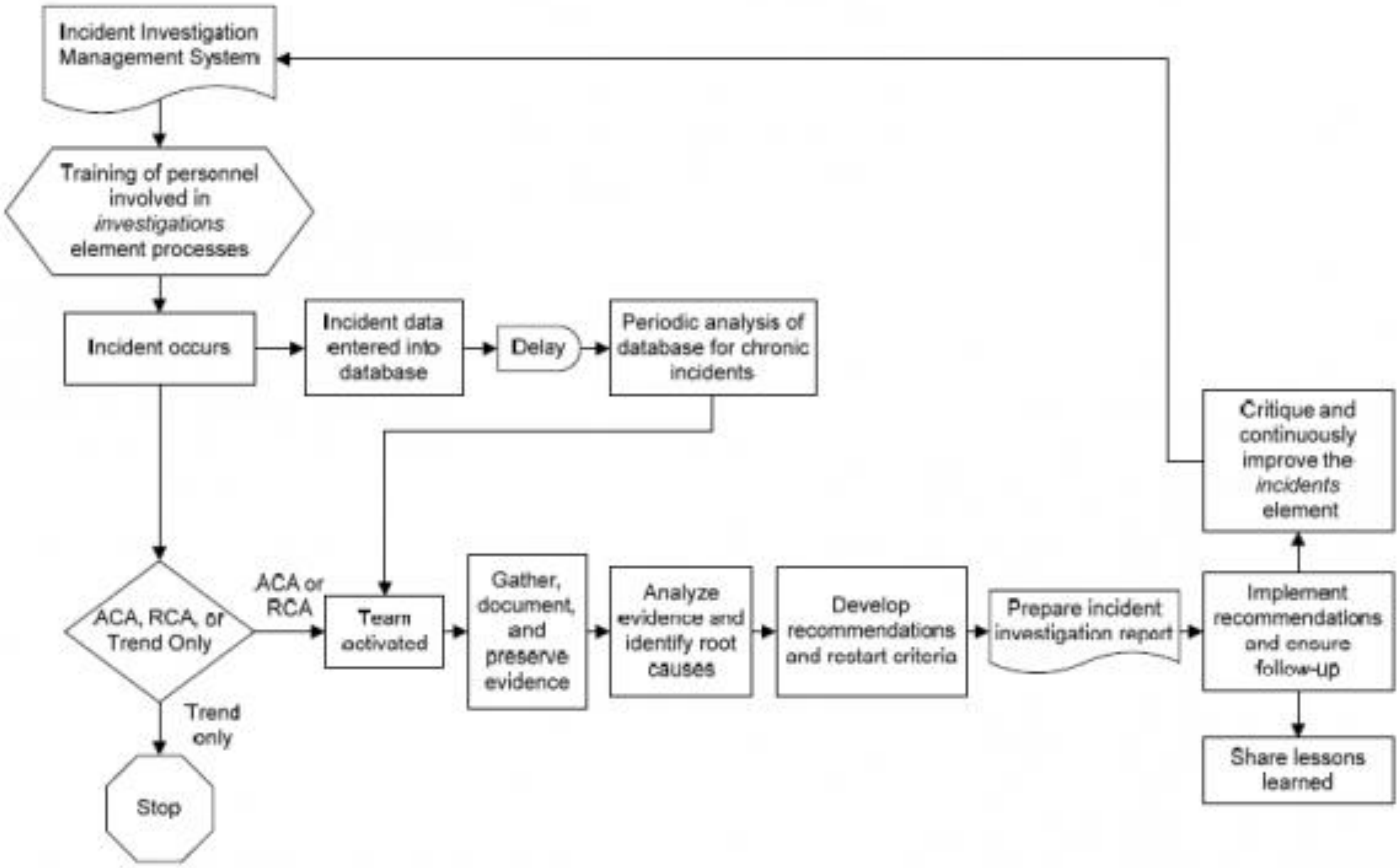
Inspect and test your safety systems to ensure that they work!

Introduction to Incident Investigation

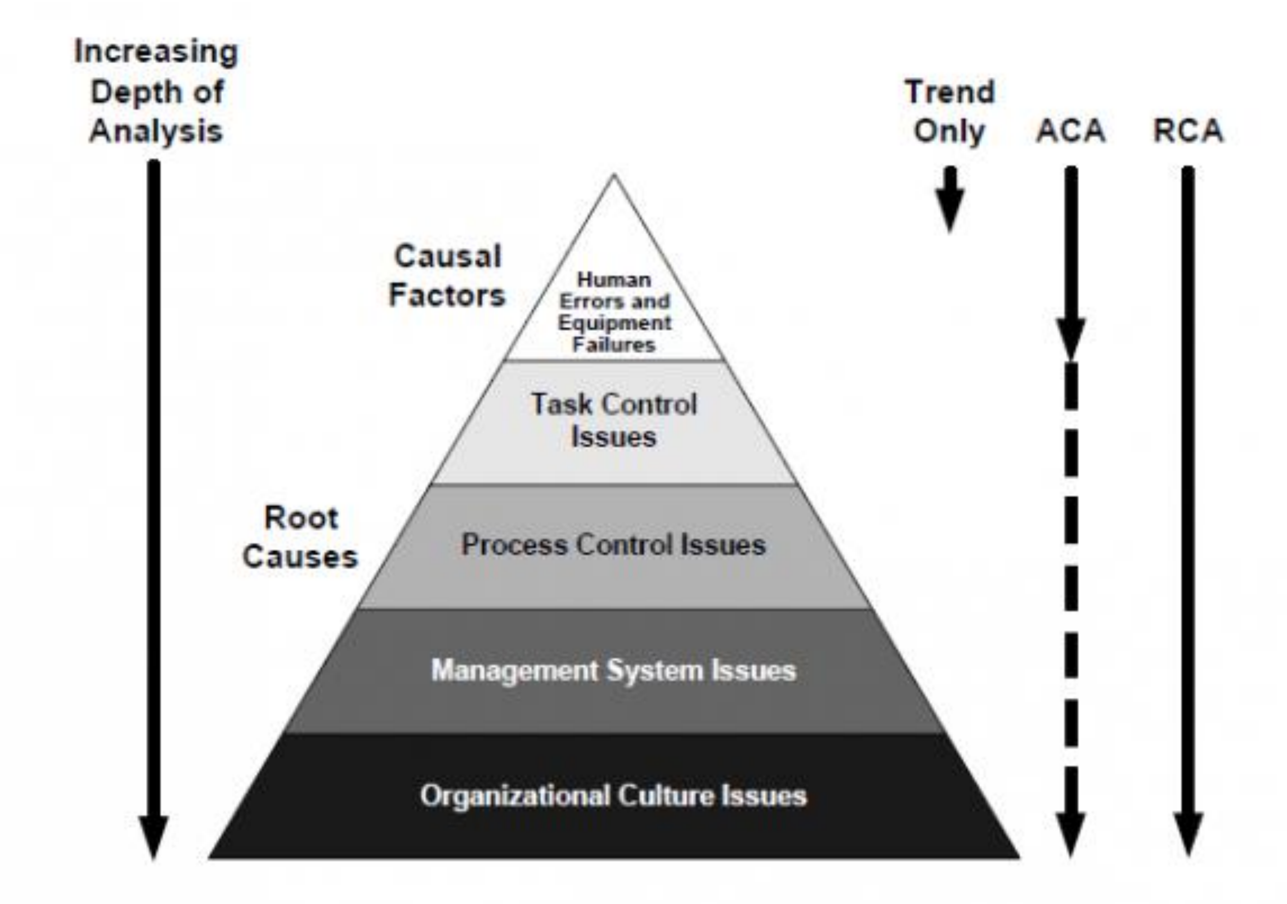
Incident categories



Incident investigation flowchart

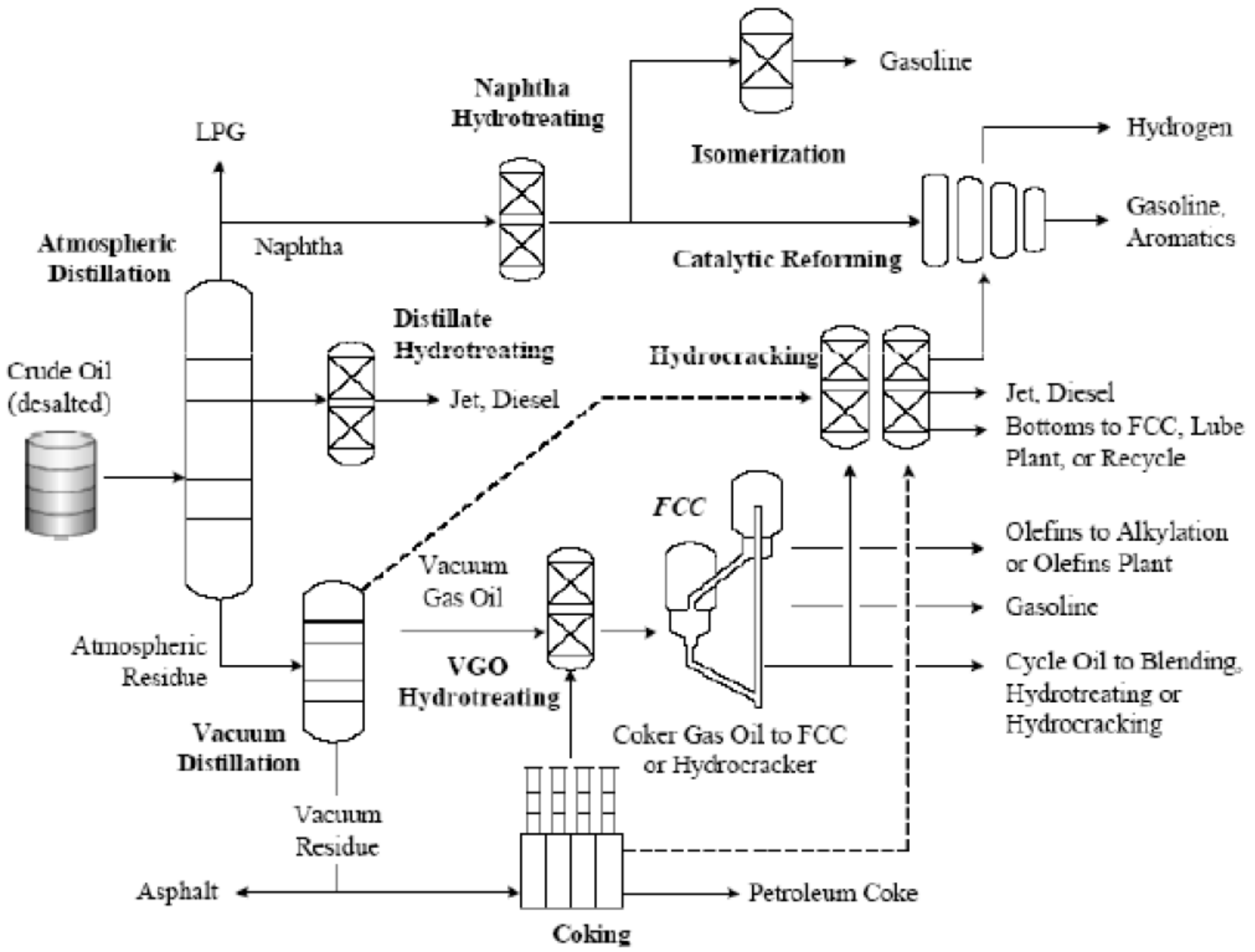


Incident investigation levels of analysis



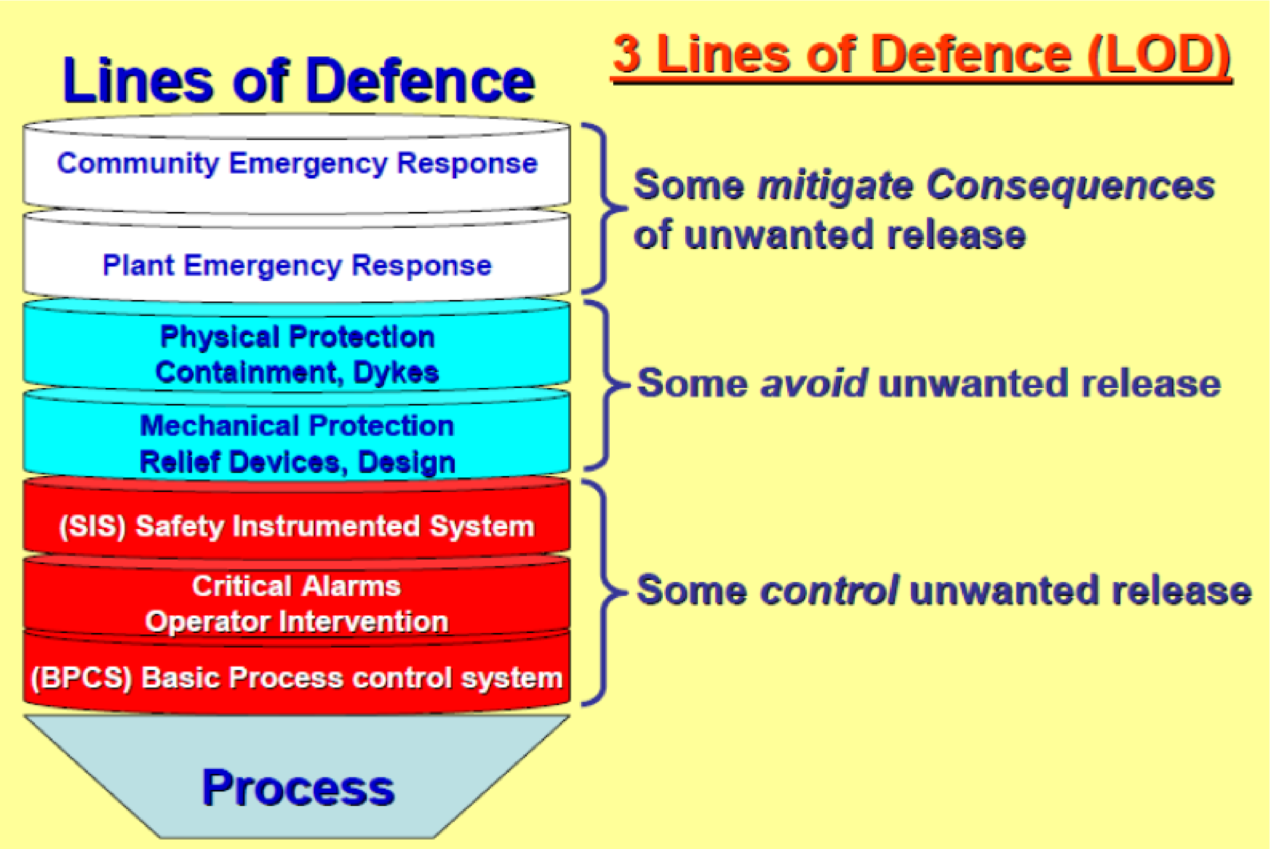
Safety in Chemical and Allied Industries

OIL REFINING



Special Risks Associated with Petroleum Refining

- Highly Flammable Material
- High Temperature / Pressure
- Hydrogen Intensive Process Technologies
- Chemicals / Solvents / Catalysts used in Process
- Corrosivity / Reactivity
- Toxicity
- Self Ignition on Leakage from System
- Uncontrolled Process Reactions
- Loss of Containment / Accidental Releases


3 Lines of Defence (LOD)
Lines of Defence
Community Emergency Response
Plant Emergency Response
Physical Protection
Containment, Dykes
Mechanical Protection
Relief Devices, Design
(SIS) Safety Instrumented System
Critical Alarms
Operator Intervention
(BPCS) Basic Process control system
Process
Some mitigate Consequences
of unwanted release
Some avoid unwanted release
Some control unwanted release

Fall-out of Major Accidents

- Anger in the local community
- Intense regulatory scrutiny
- Litigation
- Massive media coverage
- Attacks on Motives, Competence & Commitment to Safe Operations

» No easy answers. You are judged on the basis of what you did, and not what you said

» Are there Corporate Values / Code of Conduct that guide to do right things for the right reasons?

Usual Suspects

Immediate Causes

- Violation by individual
- Violation by supervisor
- Defective safety devices
- Improper decision making or lack of judgment
- Lack of knowledge of hazards
- Failure to warn
- Routine activity without thought
- Inadequate Equipment
- Inadequate workplace layout

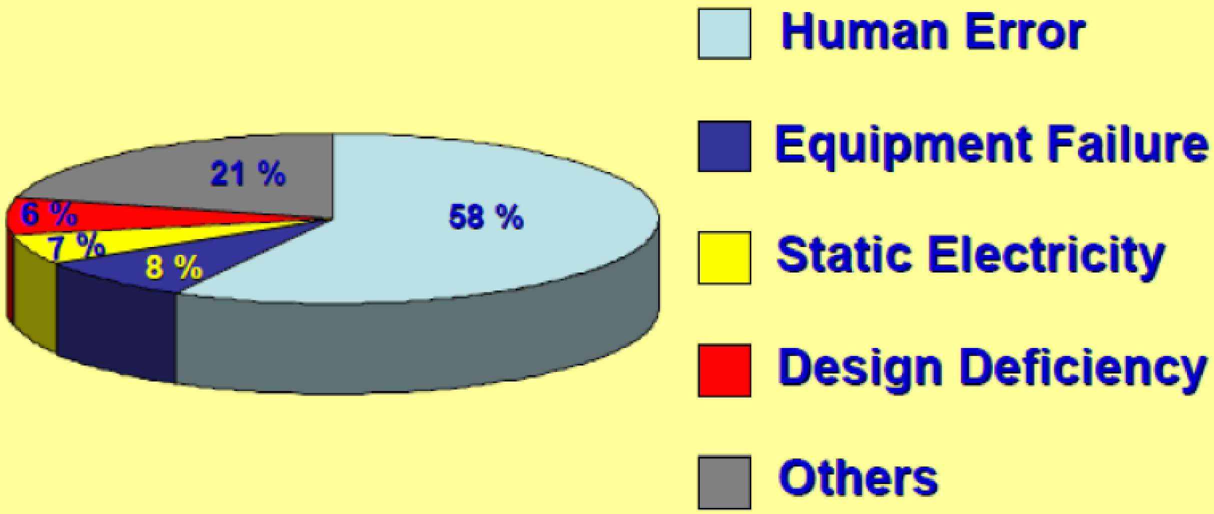
Introspect

Management System Causes (Root Causes)

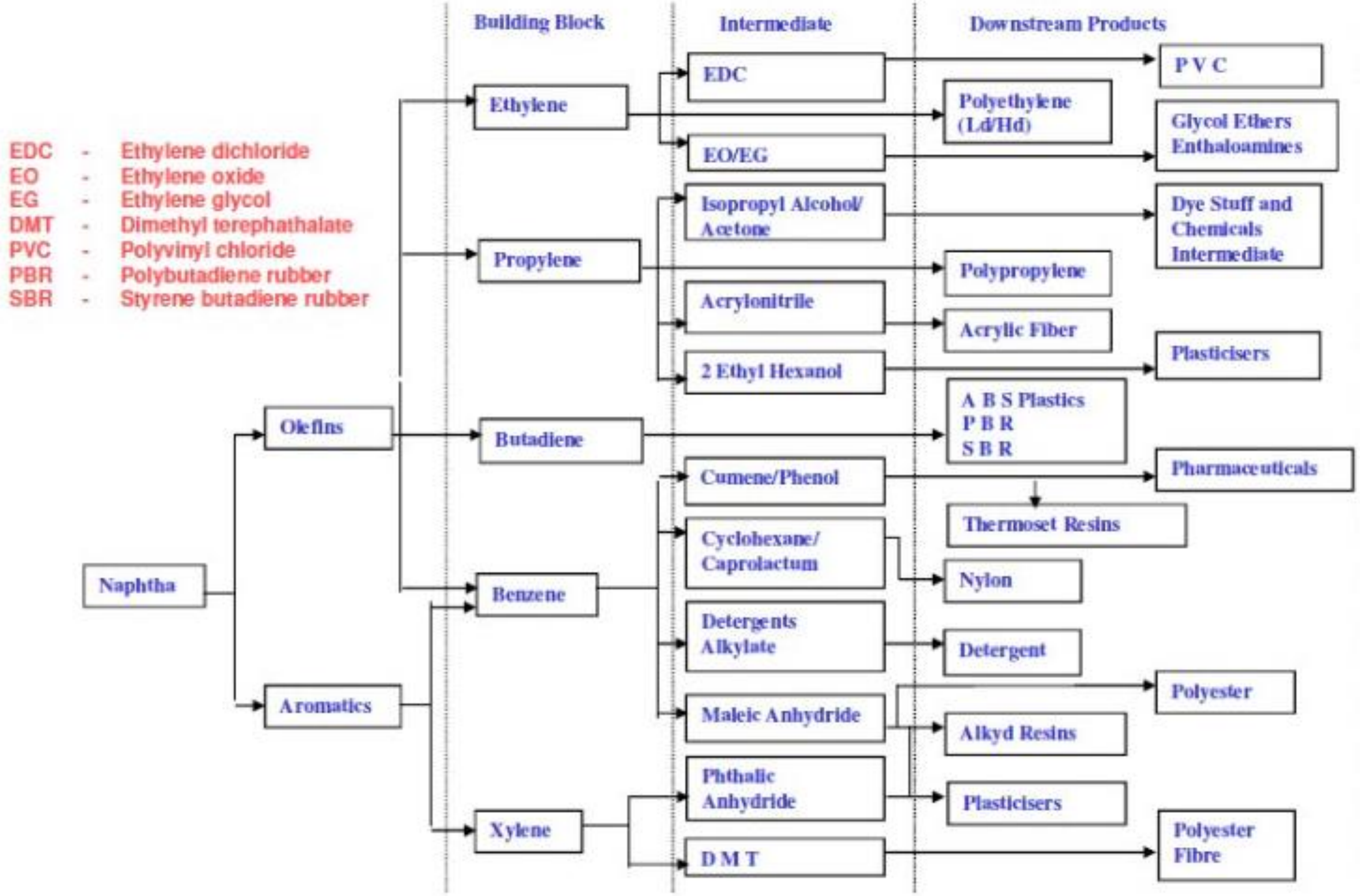
- Poor Judgment
- Inadequate Training Effort
- Inadequate Leadership
- Inadequate Enforcement of Policies / Procedures
- Improper Supervisory Example
- Inadequate Audit / Inspection
- Inadequate Identification of Hazards
- Inadequate Communication
- Inadequate Design

Comprehensive Causes of Incidents

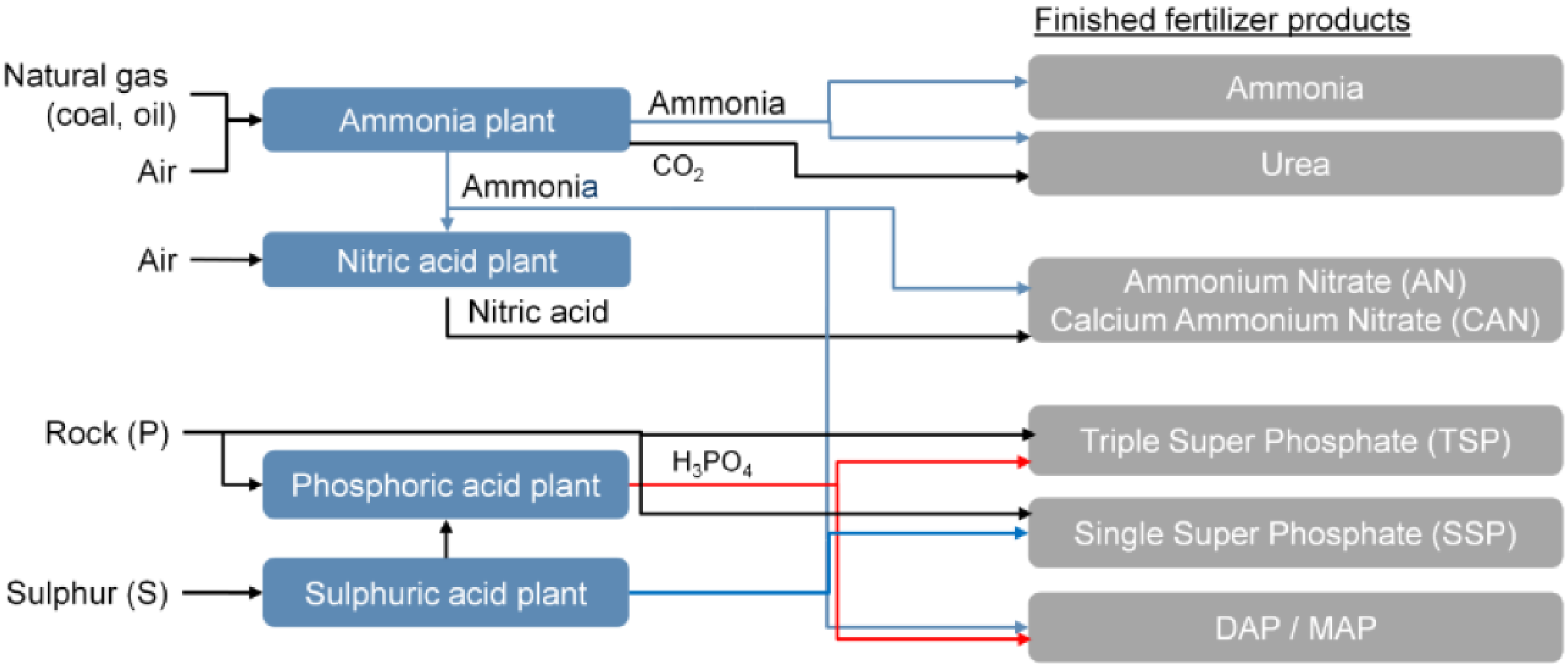
[Source OISD]



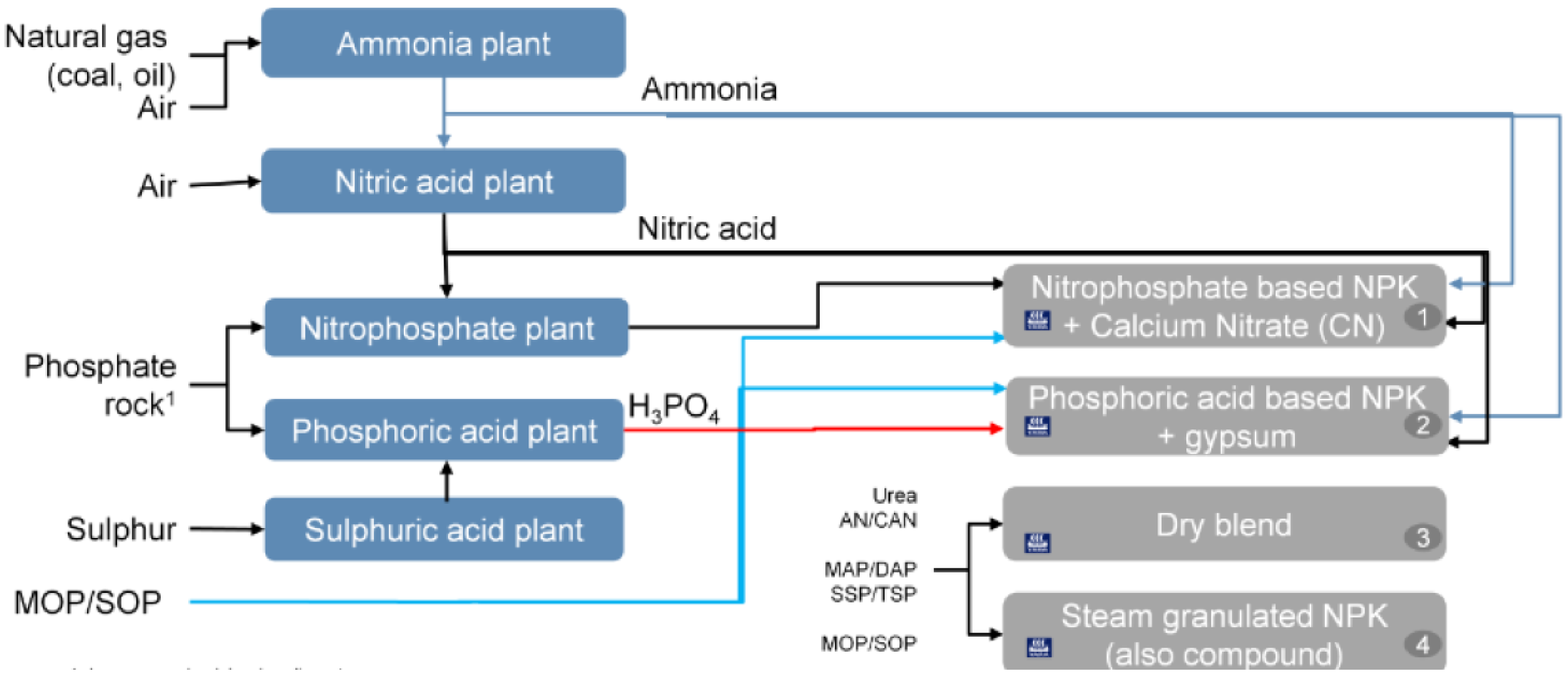
PETROCHEMICAL PRODUCT TREE



Fertilizer production routes



NPK production routes



The cement-making process