Safety in Focus

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Loss Prevention Department

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LPCRs: What, Why and How

By Robert L. Smith, Planning & Technical Services Division, Loss Prevention Department

Loss Prevention Compliance Reviews (LPCRs) are an important part of corporate governance and extending accountability for safety management performance. The program is based on Saudi Aramco's Loss Prevention Policy (LPP), which highlights 11 key principles for proponents to continuously maintain the highest standards of safety, security, health and environmental protection. The responsibilities for the aligned implementation of the corporate LPP and its expanded principles are covered in General Instruction (GI) 5.002, *Loss Prevention Policy Implementation*. Department managers are responsible for developing and managing safety programs aligned with the corporate Safety Management System (SMS).

An LPCR provides management with objective feedback on the effectiveness of their organization's loss prevention programs.

What are LPCRs?

LPCRs provide comprehensive reviews of operating facilities and help to assess performance compared to company safety expectations as outlined in the SMS and specific standards, programs and procedures. They help identify performance gaps and offer recommendations to target necessary improvements. LPCRs help determine the effectiveness of an organization's safety programs, processes and activities while addressing both operational (e.g., conditions involving facility, equipment and hardware) and personnel (workforce) safety issues.

Since inception in 1982, hundreds of LPCRs have been conducted across the company. To improve the overall effectiveness of the LPCR program, in 2002, Saudi Aramco established a core team to streamline administrative procedures, reduce manpower demands on all organizations involved, and provide a focus on the SMS in a manner that ensures assessment consistency and objectivity.

Loss Prevention Department's role

The Loss Prevention Department (LPD) provides assistance, advice and consulting services to help departments manage their safety programs. LPD conducts selected periodic reviews to ensure safety performance is in line with expectations of established standards (e.g., GIs, and corporate SMS).

LPCR process

The LPCR team is an independent group composed of highly trained specialists from across the company. The core team can be extended as necessary to provide additional technical expertise. The LPCR process includes:

1. Meeting with the department management team and their local subject matter experts.
2. Reviewing the department's SMS/ safety programs and related documentation using a customized review protocol.
3. Interviewing department management and employees about their SMS and their roles.
4. Conducting field reviews of facilities.
5. Providing the department manager with feedback and discussing key observations following the field review.
6. Developing a report for LPD management's review and approval that is sent to the proponent department manager and the head of the administrative area.
7. Communicating report findings to the administrative area and senior management and tracking progress on resolution efforts through the SAP Environment, Health and Safety (EH&S) module. There is also follow-up progress reporting at periodic intervals.

It takes approximately four weeks to complete the LPCR process (two weeks for the field review, followed by two weeks to develop, review and approve the LPCR report).

The LPCR findings

The LPCR report contains an evaluation of the department's SMS, identifying areas of strength and areas for improvement. Specific recommendations to address the deficiencies are provided. Issues posing a greater degree of risk are highlighted as "major." Identifying these types of findings are of considerable value because experience has proven that many of these types of circumstances have been observed to be causal or contributing factors in previous internal or external major incidents.

The proponent department is responsible for properly addressing the recommendations. The manager works with his team and develops an action plan that:

- Assigns each recommendation a priority and target date for completion, and identifies who will monitor/direct the implementation.
- Specifies the action items, the steps

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required, the people assigned for each task and a completion date.

- Forwards the action plan to the administrative area head and the LPD area office.
- Tracks the implementation of all recommendations.
- Provides a detailed status report of the major recommendations to LPD.

Areas of strength and areas for improvement identified during the LPCRs are published by LPD annually and can be downloaded at http://lp.aramco.com.sa/site/references/bestPractices/areas_of_strength/default.aspx. Departments are encouraged to use this information to learn and apply best practices within Saudi Aramco as they strive for continuous improvement.

In summary, the objectives of the LPCR are to:

- Assess an organization independently per GI 6.006, Loss *Prevention Compliance Reviews.*
- Verify a department's performance against the objectives and expectations of the SMS and GI 5.002.
- Provide a mechanism for supporting continuous improvement of departmental SMSs.

Saudi Aramco will conduct its business in a manner that prevents incidents and injury. The LPCR program is an important part of corporate governance and a management tool that helps operating departments achieve this objective.

Heavy Equipment Safety

By Khalid A. Al-Gublan, Abqaiq Area Loss Prevention Division

Imagine a vehicle that weighs twice as much as your family car, cannot stop as quickly and is operated by a person who may not see you. We are referring to heavy equipment, which is a vital part of operations in a variety of workplaces throughout the world, especially construction sites.

According to a 2006 study published in the *Journal of Safety Research*, nearly 63% of all heavy equipment and truck-related deaths in the US involved the equipment operators themselves and nearby construction workers. This is why it is crucial for all job site personnel to be properly trained and well versed in the hazards and risks posed by these vital pieces of machinery.

With Saudi Aramco's continued growth and expansion, construction projects are increasing in number and frequency. Adding heavy equipment and machinery increases work zone hazards and the risk for injury. Each year workers are crushed by equipment, struck by swinging backhoes, and run over or pinned between other equipment and permanent fixtures.

The types of heavy equipment involved in most fatalities are cranes, forklifts and excavators.

Cranes

Cranes play a significant role in operations, maintenance and construction activities. These complex machines require qualified and certified operators and riggers to operate safely. As they are used to lift heavy loads, they have an increased potential for catastrophic incidents if something goes wrong. All crane lifts must be carefully planned and executed to prevent serious injury and property damage. Some of the hazards associated with crane operations include:

- Boom failure due to lifting loads heavier than the safe working load (SWL).
- Contact with overhead power lines.
- Overturning when the outriggers are not properly extended.
- Dropping the load due to equipment failure or operator error.

Forklifts

Forklifts are powerful tools that move, carry, lift and stack heavy loads in almost every industry. All too often, they are regarded as common equipment and as a result, thousands of forklift incidents have occurred that involve personnel being struck by a

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forklift or falling while standing or working from pallets mounted on a forklift. Similarly, employees are injured when forklifts are unintentionally driven off loading docks or reverse without warning.

Such incidents can cause property damage, including damage to warehouse gates, overhead sprinklers, racking, pipes, walls, machinery and other equipment.

Excavators

Excavators fall into two main categories: fixed-position excavators (e.g., face shovels, backhoes, draglines and grabs), and moving excavators (e.g., bulldozers, loaders, scrapers and trenching machines). Fixed-position excavators are used mainly when handling loose soil and load from a stationary position. Most excavations are carried out using these very specialized pieces of machinery. Contact with underground utility pipes and cables is one of the most common hazards of excavator operations.

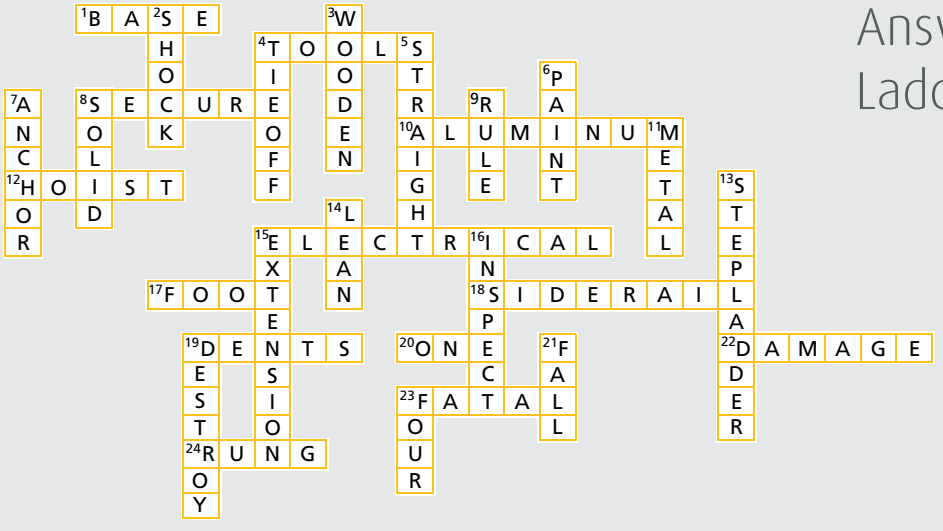
Operator responsibilities

Each piece of equipment is designed for a specific purpose and is, therefore, unique. They do, however, share many of the same safe operating rules and operator responsibilities. Key responsibilities include:

1. Operators of heavy equipment must be adequately trained and possess a valid Saudi Aramco certificate that is carried with them at all times in the workplace. The certificate must be specific to the make and model of the equipment.
2. In addition to scheduled equipment inspections, operators must inspect their equipment prior to use to ensure that its parts (e.g., seat belts, cab glass, backup alarms) are in safe operating condition. Cranes must have a valid Saudi Aramco inspection sticker.
3. The required work permits must be obtained before any heavy equipment is used in Saudi Aramco restricted areas.
4. All underground utilities and lines must be identified and marked, and the appropriate authorities notified before any work begins.
5. Before moving heavy equipment, the operator must walk around the area to confirm that it is clear. If the operator's visibility is obstructed, a designated spotter is required.
6. Operators must shut down the equipment when not in use and never leave it unattended when in use. Blades, scraper bowls and other hydraulic equipment must be lowered to the ground before the operator leaves the equipment.
7. Operators must also ensure that all the outriggers are fully extended.

When well maintained, operated by properly trained operators and only used for the job for which it was designed, heavy equipment is safe and reliable.

Answers to Last Month's Ladder Safety Crossword Puzzle



Industrial Explosions: Causes, Consequences and Prevention

By Mehmet (Nuri) Gurtan, Riyadh Area Loss Prevention Division

Explosions in process industries can result when combustible mixtures (vapor, suspended dust and fibers) ignite, or when a container fails due to overpressure. Explosions cause injuries to people and damage to physical assets due to pressure waves and flying objects, chemical impact of hazardous releases and the high heat of a fire.

Incendiary explosions

When a mixture of fuel and air is ignited in a confined space, such as a vessel or an enclosed building space, the energy released often causes catastrophic failure. Using blast relief hatches or panels to limit the damage from overpressure is known as explosion venting. This concept can also be applied to fuel storage tanks — the welded joint between the fixed roof and tank wall can be intentionally weakened to have the roof fly away, but keep the shell in place, in case of an explosion.

Flammable/combustible mixtures can also result in high-impact explosions outdoors. Such explosions are known as vapor cloud explosions (VCEs). The damage potential of a VCE is determined by the chemistry and volume of the combustible mixture, as well as congestion in the area.

During a VCE, a flame front starts at the ignition source and moves out in all directions (very similar to a balloon being inflated). If there is nothing to obstruct the flame front, it will move slower than the speed of sound. This resembles a flash fire more than an explosion. It burns things in its path but without much mechanical impact. However, when the flame front hits obstructions, such as congested areas, the flame front momentum increases, igniting more of the unburned mixture and picking up speed. If the speed exceeds the velocity of sound, a shockwave is created. This is called "detonation" and, in addition to burning things in its path, results in a highly destructive pressure wave. That is one reason why congested process areas are not desirable.

The risk from incendiary explosions can be minimized by eliminating ignition sources using engineering controls such as design features (e.g., use of electrically classified equipment) and administrative methods (e.g., controlling hot work) in areas where flammable mixtures may be present.

Overpressure explosions

Equipment that operates under pressure is designed to withstand the operating pressures and temperature ranges experienced during normal operations. Equipment with pressurized contents may explode when the pressure exceeds the strength of the design pressure envelope (vessels, piping, etc.). This can happen when the pressure rises beyond established operating limits. In addition, equipment can fail to withstand pressure due to: corrosion reducing the thickness of the shell, or an external impact such as a collision or rollover of a liquefied petroleum gas (LPG) tanker truck.

Pressure relief valves can prevent over-pressure in specific equipment. Process units have more complex systems, including instrumented control systems, depressurization systems and emergency shutdown systems.

During the operation and maintenance phase of the equipment's life cycle, corrosion is monitored to ensure that the equipment's strength does not fall below the level required for safe operation.

Overpressure explosions involving equipment containing LPG are typically caused when the vessel is exposed to an external fire that boils the liquid and expands vapor inside. If the resulting pressure rises beyond the capacity of the relief valve, an explosion occurs. Reduced shell strength at the elevated temperature is another contributing factor. These explosions are known as boiling liquid expanding vapor explosions (BLEVEs).

Explosion consequences

The consequences of a detonation resulting in an instantaneous, atmospheric overpressure are highlighted in Table 1.

Although fatalities due to overpressure normally occur when pressure is between 40 and 100 psig, they can also occur at lower overpressures when people are struck by flying objects or are hurled against stationary objects.

BLEVEs generate overpressure blast waves due to the rapid expansion of

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0.2 psig	Glass windows fail.
0.4 psig	Minor structural damage.
1 psig	People knocked down.
1 to 2 psig	Wood and nonreinforced concrete buildings fail.
2 psig	Major structural damage.
3 psig	Oil storage tanks rupture.
4 psig	Reinforced concrete buildings fail.
5 psig	Eardrums rupture.
10 psig	Complete structural damage.
10 to 30 psig	Lung damage.
40 to 100 psig	Lethality threshold.

Table 1. Consequences of instantaneous atmospheric overpressure

superheated liquid that forms a readily ignitable mixture. The existing fire ignites the mixture, resulting in a fireball. Fatalities from burns and explosions have occurred to people standing as far as 76 m (250 ft) from BLEVEs. Fatalities from being struck by a missile (broken pieces of the tank's shell) have occurred at distances of 240 m (800 ft).

Lessons Learned: LTA Procedures

By Roberto Alba, Planning & Technical Services Division, Loss Prevention Department

A procedure is a series of steps to be taken that provides guidance to consistently, efficiently and safely accomplish a specific task. Humans are inherently different in nature and they perform differently when given a task. When a task is not done properly, incidents can happen with potentially serious consequences. One way to prevent this is to ensure that proper procedures are in place for the tasks to be performed consistently and relevant personnel are trained in these procedures.

One of the leading causes of incidents in the company (and throughout the oil and gas industry) is less than adequate (LTA) procedures. These include no or incomplete written procedures for tasks to be performed.

The following scenarios describe how LTA procedures can lead to incidents.

Sewage lift station fatalities

Four contractor employees were fatally injured due to exposure to hydrogen sulfide (H_2S) gas when they entered a lift station to check a sewage leak. The first victim entered via a flight of stairs to close the pump's valves and isolate the leak. He was overcome by H_2S and immediately lost consciousness. Three contractor employees subsequently entered the lift station to rescue the first victim, fell unconscious and died.

Twelve additional personnel entered without testing the atmosphere or using any personal protective equipment (PPE) to protect against toxic gases. Four of the responding personnel needed to be rescued and hospitalized.

Fatality at a sump pit

A fatality occurred when a worker fell into an open process water sump that contained acidic, high-temperature water.

The victim was working at the pit where a screw conveyer was used to move material. As there was no written procedure, whenever the screw conveyor jammed at the bottom of the sump, employees would routinely agitate or mix the material to loosen it. The victim was seen straddling the guardrail at the sump minutes before the incident. It is believed that he was struck on the front of his hard hat by a pressurized air hose, which had disconnected from a steel pipe, causing him to lose his balance and fall into the sump.

Safety management system

These incidents highlight a number of shortcomings related to LTA procedures. If the Saudi Aramco Safety Management System (SMS) or similar management systems had been followed, the workers would have received proper training (as outlined in Element 4, "Competency and Training"), a thorough risk assessment would have been conducted prior to the work (as covered in Element 2, "Risk Assessment and Management"), proper communications would have been used (from Element 3, "Communications") and proper emergency procedures (as described in Element 8, "Emergency Response")

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would have been in place. LTA procedures for each of these elements resulted in lives being lost.

Lessons learned

An incident should be used as an opportunity to learn by determining the appropriate root causes, correcting them, and changing or preparing the procedures to accomplish the tasks safely in the future. Even with a proper procedure in place, incidents can happen when the procedures are not followed; but when there is no procedure, the likelihood of an incident increases and there can be serious consequences.

A task that has no written procedure is a common catalyst for serious incidents and ineffective emergency response. A well written, adequate procedure and associated training are vital for safe operations.

Simultaneous Safety Challenges in the Shifting Sands

By Wilmer A. Duque Sanchez, Ras Tanura Area Loss Prevention Division

- 600 kilometers of new pipeline.
- 1,300 pieces of equipment.
- 20,000 workers.
- 40,000 tons of structural steel.
- 150,000 meters of pipe.

Most of these are to be transported along a single, isolated and topographically complicated 400 km access road to an enormous and remote area of the Empty Quarter desert — Shaybah.

Amid the shifting, red dunes of the Rub' al-Khali, Shaybah's facilities are undergoing a major expansion as Saudi Aramco works to boost the recovery of hydrocarbon resources. The Shaybah expansion program includes building a grassroots natural gas liquids (NGL) recovery plant to increase the capabilities of the existing gas-oil separation plant (GOSP), construction of a new 600 km pipeline and a major upgrade of supporting and power generation facilities.

The magnitude of these projects and the remote location create safety challenges that are not normally encountered in projects and construction sites. The project to develop Shaybah has been facing and managing these hazards since inception.

Remote location and accessibility

Before work could begin, facilities had to be completed to allow equipment and personnel to travel to Shaybah safely. Around 20 parking and resting areas were built on the Batha–Shaybah road, and a daily security patrol was initiated. Drivers received road awareness brochures and global positioning satellite (GPS) devices were installed in trucks to monitor their location and speed. Heavy equipment transportation plans and workers' journey management were developed and implemented.

To further reduce people's exposure, facilities were set up in Shaybah such as grocery stores, banks, a health clinic and telecommunications.

High temperatures and humidity

Shaybah is one of the hottest places in Saudi Arabia with temperatures reaching up to 55 °C in the summer. Additionally, Shaybah frequently experiences high humidity, so a strict heat stress control program, as described in the online Saudi Aramco *Construction Safety Manual*, is implemented. This includes regular stop/work times and scheduling some activities at night during periods of heat index danger.

Emergency response and telecommunications

The many activities in Shaybah — from construction of an NGL plant to housing — cover a large area. Some activities also need to be a safe distance from residences. These extended distances create a challenge for primary health care, emergency response and telecommunications. Shaybah NGL Projects Department (SHNGLPD), Saudi Aramco Medical Services Organization (SAMSO) and contractors worked together to develop a first aid and an emergency response network and open a health care clinic for all project areas.

A medical evacuation (MEDEVAC) plan was developed for more serious medical emergencies. Shaybah is more than seven hours by road from the nearest public hospital, so a prompt and effective MEDEVAC must be carried out by air.

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Until recently, mobile coverage in this remote area was limited, with some areas unable to access service. This made day-to-day activities difficult and emergency communications and response could be compromised. Saudi Arabia's telecommunication companies have now provided additional communication towers throughout the Shaybah Field and along the Batha–Shaybah road. Radios and satellite phones can now be used.

Interface with existing plants (GOSPs)

One of the most critical challenges is the interface between existing GOSPs and the construction activities taking place inside live plant facilities, with more than 270 piping, electrical and instrumentation tie-ins that require total or partial plant and unit shutdowns.

To ensure the impact of these activities is properly assessed, authorized, communicated, documented and performed safely, SHNGLPD and the project team developed specific simultaneous operation plans for many projects. In developing the plans, the team relied on the elements of the Safety Management System (SMS), including Element 2, "Risk Assessment and Management;" Element 5, "Asset Integrity," with particular focus on the Operation and Maintenance section implementing a formal documented Management of Change (MOC) process; Element 7, "Contractors, Suppliers and Others;" and Element 6, "Safe Operations," with particular attention to work permits and accountability.

Other measures include temporary fences, site-specific safety orientation and training, updating the emergency response plan, and workshops between project team, contractor and operation personnel.

The development of Shaybah poses some unique construction, operating and safety challenges. Saudi Aramco employees and supporting organizations are working together to effectively manage these challenges, and focus on the implementation and continuous improvement of all the processes.

Resources

Resources available at Loss Prevention's homepage: http://lp.aramco.com.sa

1. **Safety Films** available from the LPD Film Library:
   - 100.034 – Safety Leadership for Everyone
   - 100.157 – Working with Cranes Safely
   - 100.219 – Forklift Handling: Safety In Dangerous Situations
   - 900.454 – The Day the Sky Caught Fire
   - 900.486 – Desert Driving
2. **Special Publications**
   - Visit LPD's special page dedicated Heavy Equipment at: http://lp.aramco.com.sa/site/education/campaigns/heavyequipment
3. **References**
   - Saudi Aramco *Safety Handbook*
   - Saudi Aramco *Construction Safety Manual*
   - Saudi Aramco General Instructions (GIs) 5.002, *Loss Prevention Policy Implementation* and 6.006, *Loss Prevention Compliance Reviews*
   - *Journal of Safety Research*, Vol. 37, Issue 5, pp.511-517, 2007.
4. **SafetySmart™**
   - The international reference site SafetySmart™ available through a special link on LPD's homepage at: http://www.safetysmart.com/safetysmart/Learner.aspx?success

The editorial staff welcomes readers' comments and ideas. Please email your suggestions to SafetyinFocus@aramco.com or mail them to *Safety in Focus*, Saudi Aramco Loss Prevention Department, A-117, Building 3150, LIP, Dhahran 31311, Saudi Arabia or call 872-8868.

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