



**sasol**

# Process Safety Barriers

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# Purpose of the process safety barriers

➤ Process safety barriers serves the following purpose:

- Prevent the occurrence or re-occurrence of a process safety incident.
- Minimise the consequence of a process safety incident.
- Protect personnel in case of a process safety incident occur.
- Protect personnel that handle a process safety incident.
- Protect the environment.

# Process safety barriers

- Alarm and operator intervention
- Trip systems
- Emergency response
- Design – Process conditions
- Inspections
- Fire and gas detection
- Use of procedures - Operator and maintenance intervention
- Relief valves
- Preventive maintenance
- Fire extinguishers, monitors and deluge systems
- Operator plant rounds & inspections
- Shutdown during an emergency

# Process safety barriers



- Maintenance - Repair triggered by inspection
- Area classification
- Control loop
- Paint system (CUI)
- Leak testing at start up
- Seals on rotating equipment
- Monitoring and operator intervention
- Proper pipe fittings
- Earthing
- Isolation of equipment
- Equipment design - Operating window
- Permit to work (PTW)
- Inerting equipment (N<sub>2</sub>)

## ➤ Purpose

- Alert the operator that a process parameter is deviating from the safe state.
- Operator confirms the status of the process parameters and takes action to return it to the safe state.
- Operator response is affected by alarms, graphics, environment, culture, training, procedures and support.

## ➤ Checks

- No alarms disabled.
- Understand the conditions and consequences if a process is operated with a process parameter in the alarm condition. (Unsafe state)
- All alarm lights working and tested at the start of the shift.
- Description of consequence, possible causes and actions to be taken when an alarm is activated.
- Process parameters set to the correct alarm setting.
  - Know different type of alarms i.e. hardware alarm, PV high and low alarms, deviation alarms, OP high and low alarms, etc.

## ➤ Purpose

- An automatic function performed by SIS, DCS, etc. to put a process in a safe mode.
- Trigger by a process parameter that go into an unsafe state.
- Proceeded by an alarm to give the operator change to correct the conditions.
- Function on demand.
- It is a legal requirement that a trip system must be in a working condition.

## ➤ Checks

- Maintain trips systems as per maintenance strategy and schedule.
- Trips and safety systems have to be active at all times.
- If it is required to bypass a trip use the correct procedure to bypass the trip.
- Record trip bypasses in the trip register and confirm that the trip is re-instated after sign off.
- List of trips, settings and actions to be taken must be available to the operators.

## ➤ Purpose

- The goal is to protect people, environment and assets.
- Organising, coordinating and directing of resources to respond and bring the emergency under control.
- Emergency response plan describe the actions to be taken during an emergency.

## ➤ Checks

- Conduct emergency exercises on a regular basis.
- Define credible scenarios.
- Update emergency response plan as per requirements.
- Training of personnel on revised emergency response plan.
- Analyse actions after emergency or exercise and update the emergency response plan.
- Trained emergency coordinators are available at all times.

## ➤ Purpose

- Design parameter is the parameter for which a process or equipment is designed to operate safely.
- Safe operating limits will not cause harm to people, environment and equipment.
- An operating envelope for a process unit describe the design and the maximum allowable operating conditions.

## ➤ Checks

- Availability of a list with the critical design and operating parameters.
- A process unit is not operated outside the safe operating limits.
- Description of the actions to be taken to prevent exceeding the safe operating conditions.
- Consequences when exceeding the safe operating conditions.
- Availability of the operating envelope to operators.

# Inspection by maintenance departments

## ➤ Inspection

- An organised examination or formal evaluation exercise.
- Involves measurements, tests that apply to certain characteristics in regard to the object or equipment.
- Identify degradation mechanisms and conditions of the object.
- Equipment can be inspected visually.
- Inspections must focus on process safety impact.

## ➤ Typical equipment to be inspected:

- Process safety critical equipment
- Pressure equipment, relief systems, flare headers.
- Structures.
- Fireproofing.
- Lifting and hoisting equipment.
- Flexible hose.

## ➤ Purpose:

- System consisting of circuits arranged to monitor the environment and signals that a LOPC has occurred.
- Immediate response is required to eliminate the consequences.
- Consist of fire alarms, gas alarms, sirens, auto gas detectors, etc.

## ➤ Checks:

- Detection systems must be operation at all times.
- Additional mitigation systems in place when detection system not in operation.
- System to be tested as per maintenance strategy and schedule.
- Defects to be repaired as soon as possible normally emergency.
- Maintain calibration records of gas detection equipment.

# Use of Procedures - Operator and Maintenance Intervention



## ➤ Purpose:

- Operating procedures are a step-by-step instruction compiled for workers to carry out tasks safely.
- Maintenance procedures are a set of instructions that specify how maintenance is to be performed to reinstate the integrity and assure safe operations of equipment.

## ➤ Checks:

- Procedures must be available at all times and updated. (Hard or soft copy)
- Personnel trained on the procedures and proof of training available.
- Checklist must be signed off and verified after use.

# Relief valves

## ➤ Purpose:

- Control or limit the pressure in a system which can build up during a plant upset.
- Pressure relief by allowing the pressurised fluid to flow from an auxiliary passage out of the system.
- Set at a pre-determine pressure to protect pressure equipment.

## ➤ Checks:

- Managing the system that contains servicing procedure and schedule.
- Maintain list that have data sheets of relief systems.
- Design case for the relief system.
- Discharge routing of the relief system to a safe location.
- Set at the correct pressure and installed correctly.
- Handle and transport in the correct manner after servicing.

# Preventive Maintenance

## ➤ Purpose:

- Maintenance regularly performed on equipment to lessen the likelihood of failing.
- Maintenance work performed while still working to prevent unexpected breakdowns.
- Assure optimal working conditions and ensures extend the life span of the equipment.

## ➤ Checks:

- Maintenance strategy approved and in the maintenance management system.
- Formal process available to cancel or delay the preventative maintenance.
- Updating of the maintenance strategy if deviations are found.

# First line fire fighting equipment

## ➤ Fire Extinguishers, Monitors and Deluge Systems

### ➤ Purpose:

- Equipment used by emergency responders and personnel to control the consequence of a process safety event.
- Maintain, inspect and test to ensure proper working order.
- Proper functioning can minimise personnel injuries and asset damage.

### ➤ Checks:

- Eye wash and safety shower – check and flushing.
- Fire extinguisher – inspect as per schedule.
- Location of equipment indicated.
- Equipment not obstructed and accessible.
- Fire water lines above ground winterised.
- Deluge system tested and blocked nozzles repaired.
- Correct type of equipment installed.

# Operator rounds and plant inspections

## ➤ Purpose:

- Monitoring and checking the of process parameters by process operators.
- Confirmation of the state of the process in the field and inside on the panel.
- Confirm the state of equipment that is in operation.

## ➤ Checks:

- Number of deviations reported by the operators after inspections.
- Number of defects loaded for defects found on the unit.
- Confirm if defects are tagged.
- Readings taken in the field and action taken to rectify deviations.
- Completeness and the quality of the shift logs.
- Field readings compared with DCS readings.

# Shutdown during Emergency

## ➤ Purpose:

- Special procedures required to handle emergencies.
- Step-by-step actions to be followed in case of an emergency to bring the unit to a safe state.
- Quick, clear and effective actions to help to ease the situation and reduce the consequences.

## ➤ Checks:

- Emergency procedures revised as per schedule.
- Operator training on the emergency procedures.
- Deviations occurred during the use of the procedure addressed during the revision.
- Procedures to be available at all times, hard or soft copy.
- Emergency procedures to be included in the SOP.
- Personnel tested and retrain on the emergency procedures.

## ➤ Maintenance/Repair Triggered by Inspection

- Equipment integrity is supported by timely response to Level 1 CAIRs (Corrective Action Inspection Repair), and other inspection identified items with Process Safety impact. In scope are:
  - Pressure Equipment.
  - Fire proofing.
  - Structure.
  - Hoses & flexible hoses.
  - Electrical equipment\*
  - Lifting and Hoisting equipment\*

\*: Note: all of this focused on process safety impacts.

- See Inspection mentioned on:
  - IPF in trip systems.
  - Alarms - Alarm and Operator Intervention.
  - Earthing.
  - Painting, Coating and Isolation.
  - Control loops.
  - Fire and Gas Detection.

# Maintenance/Repair Triggered by Inspection

## ➤ Purpose:

- Defects found during plant inspections by maintenance personnel and reported in the maintenance management system.
- Equipment integrity is improved by timeously reporting and repairing of defects.

## ➤ Checks:

- List available of the defects loaded during maintenance inspections.
- Defects loaded with correct repair priority.
- Defects repaired according to the determined priority.
- Personnel informed if defect is rejected.

## ➤ Purpose

- Plat areas of the unit that is classified so that electrical equipment installed or brought into the area meet the specific design criteria.
- Areas in which an explosive gas atmosphere maybe present in quantities that require special precautions.
- Classification method to analyse and classifying the environment where an explosive atmosphere may occur.

## ➤ The following information is required for the HAC process

- MOC (Current MOC and all MOCs since last HAC)
- Process flow diagrams (PFD's)
- Mechanical flow diagrams (MFD's)
- Equipment layout diagrams (plot plans)
- Material Safety Data Sheets (MSDS)
- Mass Balances / Chemical Compositions of Mixed products
- Operating Envelope / Process Description

## ➤ Identification of all sources of release is as follows:

- Each item of process equipment such as pumps, tanks, compressors, pipelines, vessels, flanges etc., is considered to be a potential source of release.
- All items that do not or cannot contain any flammable material are removed from the list.
- Relief valves which vent into closed flare systems are also removed from the list.
- The remaining items are then listed as potential sources of release.

## ➤ Checks:

- Electrical classification drawings updated.
- Electrical classification drawings displayed in the control room.
- Equipment installed as per the area classification.
- Permit to work issued for equipment used in a classified area, not complying with the area classification.
- Area classification revised after changes were made in the area.

Gas	Dust	Hazardous Area Characteristics
Zone 0	Zone 20	A hazardous atmosphere is highly likely to be present and may be present for long periods of time (> 1000 hours per year) or even continuously
Zone 1	Zone 21	A hazardous atmosphere is possible but unlikely to be present and may be present for long periods of time (> 10 < 1000 hours per year)
Zone 2	Zone 22	A hazardous atmosphere is not likely to be present in normal operation or infrequently and for short periods of time (< 10 hours per year)

## ➤ Purpose

- Proper maintained control loops support stable unit operation and minimising the potential for process safety incidents.
- Advantages of automatic process control:
  - Safety – A process controller monitors the key process variable which it is set up to control this result in safer unit operation.
  - Environmental protection – Process control helps to minimize spills, unnecessary flaring and venting etc.
  - Equipment protection – Controlling processes within normal bounds will help to preserve the processing equipment.
  - Smooth plant operation – Because corrective action can be taken immediately the unit will run more smoothly.
  - Product quality – Automatic process controllers keep product on-spec more consistently.
  - Profit optimization – Because key process variables can be kept at the optimal value the unit will run more profitable.
  - Monitoring and diagnosis – Key process variable are historised which would help to identify control issues if arise.

# Control loop

- Common base layer control problems causing operating in a different range than normal are due to:
  - Sensing instrument.
  - Valve.
  - Controller tuning.
- Sensor problems
  - Total sensor failure - when a sensor breaks and does not supply a measurement value.
  - Sensor bias –refers to the situation where a sensor gives a measurement that is consistently incorrect by a certain value.
- Valve problems
  - Sticky valves – sticky is often used to describe the stickiness of a mechanic control valve.
  - Dead band – The phenomenon where the valve opening can change by a certain amount while the PV does not change.
  - Valve sizing.

## ➤ Checks:

- Control loop to operate in the correct mode (Auto/cascade)
- Defects loaded for control loops operating in manual mode.
- Control loops control the plant in a steady state.
- Control valve bypasses in the closed position.

# Paint system (CUI)

## ➤ Purpose

- Prevent internal and external corrosion and maintain the integrity of the equipment.
- Used to protect steel by sequential paint coatings usually a primer and finishing coating.
- General corrosion protection by a paint is directly proportional to the dry film thickness.
- Classification of paint:
  - Primer
    - Classified according to the corrosion inhibitive pigments in the formulation i.e. metallic zinc primers, etc.
    - Inhibitive pigments incorporate into range of binder resins i.e. zinc phosphates alkyd primer, zinc phosphates epoxy primer, etc.
  - Intermediate and finish coats
    - Classified according to their binders i.e. epoxies, vinyl, urethanes, etc.

## ➤ Checks:

- Paint of structures in good condition.
- No rust visible.
- Defects loaded for damaged paint or rust.
- Equipment painted the correct colour.
- Correct paint applied to equipment and piping.
- QCP available for internal and external painting of equipment.

# Leak Testing at Start Up

## ➤ Purpose:

- A leak is a fluid flowing through the operating envelope into the atmosphere.
- Prevent LOPC during start up, shut down and normal operation of a plant preventing a process safety incident.
- Leak testing is done by means of a stand test using an inert gas.

## ➤ Checks:

- Stand test was done during start-up of the plant.
- Stand test result signed off by a senior person.
- Soap test done on flanges that was opened for maintenance actions.
- Double block and bleed valves in the correct position.
- Visible spillages during normal operations.

## ➤ Purpose

- Fluid can leak out between the rotating shaft and the stationary equipment.
- Seals use rigid and stationary equipment that maintain contact at a sealing interface sliding on each other.
- Elements are both hydraulically and mechanically loaded with a spring or other device to maintain contact.
- Functional components:
  - Primary sealing face;- Hard material embedded in the casing and softer material on rotating assembly.
  - Secondary seal face:- Points in the seal requiring barrier fluid but not rotating i.e. O-rings, etc.
  - Actuation force:- Keep the seal faces in contact normally a spring or the pressure of the sealing fluid.
  - A method to be provided to ensure that non-rotation of the secondary sealing face.

## ➤ Checks:

- Correct seal installed and seal flush supplied.
- No leaks from seals of the rotating equipment.
- Splash rings installed.
- Condition monitoring results.
- Bearing oil level and the presence of water in the bearing oil.

## ➤ Purpose:

- Process variable is a measured characteristic of the process that changes with each repetition of the process.
- Upper and lower limits are the limits a variable can be in to produce quality products.
- Monitoring allow for early detection of problems so that preventative action can be taken.

## ➤ Checks:

- Variables to be controlled in the require limits.
- Control in a steady state.
- Actions to rectify a deviation to be written and available.
- Field variables monitored by operators and compared with DCS values.
- The trending and proactive Monitoring of Operator Intervention. Field Monitoring - e.g. tank levels and Operator Intervention

# Proper Pipe Fittings

## ➤ Purpose:

- Fittings are used to connect straight hard piping sections.
- Connections at the end of flexible and utility hoses to connect to the process or utility supply.
- Maintain the separation between the process and the atmosphere and it meet the require design specification.

## ➤ Checks:

- Correct fittings fitted to a utility hose.
- Correct hose and fitting used for a utility.
- Nitrogen utility couplings tag welded to the utility point.
- Flexible hoses not in walkways properly lay down and supported to prevent abrasion.

# Earthing

## ➤ Purpose:

- Earthing is the establishment of a continuous electrically path between a conducting body or material and the general mass of the earth.
- Bonding is the establishment of a continuous electrically path between two or more conducting bodies or material using electrical wire.
- Provide protection against hazards associated with lightning, static electricity and electrical faults.

## ➤ Checks:

- Earth cables install and intact on all electrical equipment.
- Earth test done as per schedule.
- All process equipment earthed.
- Welding machines properly earthed when in use on the plant.

# Isolation of Equipment

## ➤ Purpose:

- Isolate machinery and process equipment from possible energy sources (electrical & pressure).
- Important to isolate machinery & equipment from energy sources during maintenance, repairs or service.
- Isolation ensure safe access for inspection and maintenance actions by blocking liquid, gas, electrical current or any other stored energy.

## ➤ Checks:

- Process equipment locked or blanked as per isolation procedure.
- Lock register updated and signed correctly.
- Electrical isolation process used for electrical equipment.

# Equipment Design - Operating Window

## ➤ Purpose:

- Design parameters are the set parameters that indicate the maximum that the equipment can handle.
- Operating parameters are the parameters that can be maintained for long periods and ensure safe operation.
- Operate the equipment within defined limits.

## ➤ Checks:

- Parameters to be indicated in the operating envelopes and available.
- Alarms set correctly to alert operator of a deviation.
- Actions listed to correct the deviation.
- Consequences if parameters are exceeded.
- OWAP been monitored and action taken when exceeded.

# Permit to Work (PTW)

## ➤ Purpose:

- Ensure safe making of equipment, systems and associated areas prior to executing a task.
- Appropriated precautions for maintaining the safe conditions during task execution.
- Permit is formal written document that control work on or near process equipment.

## ➤ Items:

- Permit audits been done and recommendations implemented.
- Permit exemptions approved and displayed.
- List of approved permit issuers and receivers available.
- Permission of permit issuers and receivers signed.

# Inerting Equipment (N<sub>2</sub>)

## ➤ Purpose:

- Decrease the probability of combustion of flammable material stored in a confined space by maintaining a chemical that is non-reactive material in the space.
- Nitrogen is a diatomic molecule in nature with a triple bond between molecules and is not inert as most noble gases.

## ➤ Items:

- Equipment purged prior to start-up and confirmed oxygen free.
- Inerting system on equipment commissioned.
- Manual inerting systems valves to be in the correct position.
- Vents from inerting systems to atmosphere free from debris and not obstructed.
- Vents to atmosphere constructed to prevent blockages and obstructions.



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