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Study of P&ID, Safeguarding Philosophy, Design Basis and Its Features

Dr. Nihal Anwar Siddiqui[a]*, Nitin Minde[b], Prasenjit Mondal[a], Akhil K Vijayakumar[a]

[a]*University of Petroleum and Energy Studies, Dehradum, 248007, India*

[b]*H.O.D. Process Department, Worley Parsons Sea India Pvt. Ltd.*

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ABSTRACT

Process Flow Scheme is used in chemical and process engineering to indicate the general flow of plant processes and equipment. The PFD displays the relationship between major equipment of a plant facility and does not show minor details such as piping details and designations. A diagram which shows the interconnection of process equipment and the instrumentation used to control the process. In the process industry, a standard set of symbols is used to prepare drawings of processes. Through this project, Process Flow Diagrams were studied in accordance with specific pre-defined standards and analyzed thoroughly so that it would make the development of Process Engineering Flow Scheme very easier. Process Engineering Flow Schemes, also known as Process & Instrumentation Diagrams were made from PFS after segregating each Process Flow Diagram into various segments on the basis of its design basis and philosophy. After implementing the safeguarding features in the PEFS, Process Safety Flow Schemes were prepared which were intended to be the desired outcome. After getting client comments on various sections, the final sample was issued for approval from the Home Office.

1. Introduction

Process flow diagrams (PFDs) are used in chemical and process engineering. These diagrams show the flow of chemicals and the equipment involved in the process. Generally, a Process Flow Diagram shows only the major equipment and doesn't show details. A Process and Instrument Drawing (P&ID) includes more details than a PFD. It includes major and minor flows, control loops and instrumentation. P&ID is sometimes referred to as a Piping and Instrumentation Drawing. These diagrams are also called flow sheets. P&IDs are used by process technicians and instrument and electrical, Process, safety, and engineering personnel.

Process technology information will be a part of the process safety information package and should include employer-established criteria for maximum inventory levels for process chemicals; limits beyond which would be considered upset conditions; and a qualitative estimate of the consequences or results of deviation that could occur if operating beyond the established process limits. Employers are encouraged to use diagrams that will help users understand the process.

2. Scope

This project will cover Process aspects relating to equipment such as machinery, tanks, vessels and Process handling equipment together with any associated systems that are necessary to ensure safe installation,

* *Corresponding author.* Tel.: +91-7351729805.
E-mail address: akv9005@gmail.com

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commissioning, operation, maintenance, decommissioning and removal of such equipment.

The following areas shall be considered:

- Design
- Manufacture
- Installation
- Commission
- Operation
- Maintenance
- Equipment specific

Many of the Process design requirements to achieve safe operation and maintenance of equipment are set out in industry design codes and practices.

Safety in Design (SID) is one of the three elements of Worley Parsons SEAL process (Safe and Sustainable Engineering for Asset Lifecycle), and focuses on increasing the inherent safety of designs.

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3. About the Project

Objectives:

- To study P&ID of RHIP (RABAB-HARWEEL-INTEGRATED PLANT) live project
- To analyze the design basis for the integration project
- To prepare PSFS from PEFS after implementing Safeguarding Philosophy
- To check whether all safeguards are implemented in both FEED and detail design stage

Operations Philosophy:

- The objectives for operations over the asset lifecycle are to:
- Demonstrate sound HSE and sustainable development management.
- Ensure acceptable risk to personnel is appropriately managed and controlled.
- Ensure the integrity and safeguarding of all wells and production facilities
- Maintain production availability in line with delivery requirements.
- Maximize production and the ultimate recovery from the fields.
- Provide and develop the competencies of the workforce.
- Use state of the art technologies to arrive at minimum manning levels
- Explain how the asset will be operated and maintained.

Key Operating Principles:

- Achieve ALARP operations & minimize human exposure risk through plant design
- Segregate high and low risk areas within the plant layout (Apply the guideline for toxic facility layout).
- Reduce the probability of toxic gas release by optimizing leak paths in consideration of operability and maintainability of the facilities. Provide reliable and quality assured equipment with minimum maintenance requirements.
- Minimize infield manning: The Central Control Room (CCR) shall be permanently manned 24 hours a day by 4 panel operators and 1 shift supervisor.
- Key support staff will be Interior based during Start-Up and Initial Operations such as Process Support, Operations Support, etc.
- Planned maintenance will be carried out during dayshift.
- Breakdown maintenance during night time will be carried only by exception and will be subject to risk assessment to ensure risk is ALARP.
- A proactive working environment based on a high level of work planning and a competent and disciplined workforce.
- Maintenance Technicians work in all areas where their discipline is required.
- Plant Operators – Work in specific areas, require training and competency assessment to move into other areas of the plant, e.g. Utilities, GSU, Sour Gas Injection, CCR, etc.

Mitigate Consequences of Toxic Gas Releases:

- Provide a Leak Management System (detection, analysis, remediation, analyse/improve).
- Provide an Emergency Response Management System to ensure safe and quick evacuation of site personnel to dedicated muster locations.
- Provide, maintain and regularly drill a set of Emergency Response procedures that covers realistic emergency scenarios.
- Provide “shelter in place” (no TSR Concept for RHIP) for Central Control Room (CCR) staff within the CCR Building.

Assure the Process and Technical Integrity of all process facilities:

- Technical Integrity established in Design and based on the PDO Technical Integrity Framework.
- Correct material selection for sour service and QA/QC attention to detail.
- Demonstrable life cycle design integrity, underpinned by early definition of safety critical elements and performance standards, and life cycle cost (Capex/Opex) evaluation.

- For all equipment the full supply chain management systems are to be established all the way down to component level.
- Provide a Competency Development, Assessment & Assurance System for all RHIP operations staff, and a full development and training plan in line with Project schedule.
- Optimize maintenance and inspection strategies to meet availability target by applying Risk and Reliability Maintenance (RRM) principles
- Compliance to Operating Envelopes will be monitored under the Operational Integrity Assurance (OIA) program.
- Develop an Alarm Management Strategy using Ensuring Safe Production (ESP)/Operations Integrity (OI).
- Implement a rigorous, robust and comprehensive Corrosion and Integrity Management System (CIMS).
- Provide Flange Management System.

Maximize Product delivery:

- Optimize Plant Availability: o Develop a RAM model to be used for optimizing plant design and to meet plant availability target during Design and Execute Phases.
- Design for safe SIMOPS.
- Optimize maintenance and inspection strategies to meet availability target through RRM.
- Maximum efficiency/reliability of the facilities
- Considering and balancing to Project NPV.

Minimize OPEX:

- Apply a Chemicals Management System to optimize all production and process chemical costs.
- Implement a Logistics Management System to optimize all logistics costs.
- Implement an Operations Contracting Strategy and Contract Management System to ensure optimum value from contracts.
- Optimize maintenance cost.
- Minimize infield manning.

Safeguarding Philosophy:

The main objectives of the shutdown system (Safeguarding system) are:

- To protect the personnel
- To avoid or minimize the pollution to environment
- To protect the Assets
- To avoid or minimize the production losses

Safeguards are systems or elements that serve as the different levels of protection against uncontrolled loss of containment. The process safeguarding system is required to reduce the risks of malfunction of plant equipment, in terms of hazards to personnel, environment and economic loss, to a level that is **A**s **L**ow **A**s **R**easonably **P**racticable (**ALARP**).

Over Pressure Protection:

The process safeguarding system must ensure that suitable protection is provided against the maximum pressure that can be generated by the worst credible malfunction. There are essentially three ultimate safeguard options to protect against overpressure:

- Fully pressure rated equipment
- Relief valves
- Instrumented Protective Function only (HIPPS).

Under Pressure Protection:

Certain process can develop sub atmospheric pressure conditions generated by the worst credible scenario. The process safeguarding system must ensure suitable protection against minimum pressure or vacuum conditions. The ultimate safeguard for under pressure can be:

- Design for vacuum
- Provision of Vacuum Relief valves

Safe Shutdown:

In case of any malfunction of the plant equipment or its associated control instrumentation giving rise to a hazard for personnel or the environment, or potentially leading to consequences of economic loss (e.g. damage of main equipment or severe production loss), the safeguarding system will bring automatically the facility to a safe condition. The safeguarding system shall also prevent the start-up of system /unit/ equipment till a safe start conditions are satisfied.

The safeguarding system shall also bring the facility to a safe condition in case of:

- Confirmed detection of fire
- Confirmed Hydrocarbon gas (based on Lower Flammability Limit) / Toxic gas (based on H_2S) detection
- Instrument air failure
- Electrical supply failure
- High Level in Flare KO drum/s
- Manual Action ESD push button (Remote / Local)

4. Results and Discussion

Process Flow Scheme (PFS):

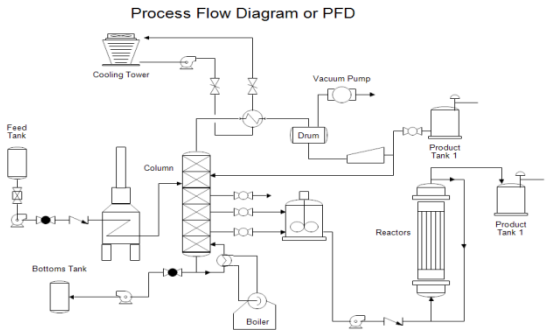
A Process Flow Scheme (PFS) or Process Flow Diagram - PFD - (or System Flow Diagram - SFD) shows the relationships between the major components in the system. PFS also tabulate process design values for the components in different operating modes, typical minimum, normal and maximum. A PFS does not show minor components, piping systems,

piping ratings and designations.

A PFS should include:

- Process Piping
- Major equipment symbols, names and identification numbers
- Control, valves and valves that affect operation of the system
- Interconnection with other systems
- Major bypass and recirculation lines
- System ratings and operational values as minimum, normal and maximum flow, temperature and pressure
- Composition of fluids

This figure depicts a small and simplified PFS or PFD:



System Flow Diagrams should not include:

- pipe class
- pipe line numbers
- minor bypass lines
- isolation and shutoff valves
- maintenance vents and drains
- relief and safety valve
- code class information
- seismic class information

Advantages of Process Flow Scheme:

The process flow chart providing a visual representation of industrial process equipment is interconnected by a system of pipelines. It has the following six benefits.

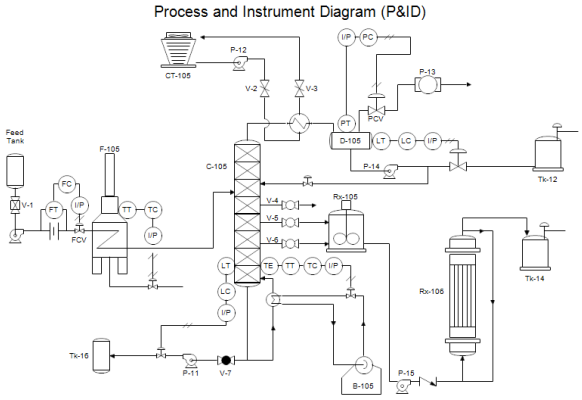
- Gives everyone a clear understanding of the process.
- Shows the plant design basis indicating feedstock, product and main streams flow rates and operating conditions.
- Help to identify the scope of the process.
- Facilitate teamwork and communication.
- Shows graphically the arrangement of major equipment, process lines and main control loops.
- Improves utilities, which are used continuously in the process.

Process Engineering Flow Scheme (PEFS):

Process Engineering Flow Scheme (PEFS) or Piping (or Process) and Instrumentation Diagram (P&ID) is also known as the mechanical flow diagram and piping and instrumentation diagram. A P&ID is a complex representation of the various units found in a plant. It is used by people in a variety of crafts. The primary users of the document after plant start-up are process technicians and instrument and electrical, mechanical, safety, and engineering personnel.

P&IDs provide information needed by engineers to begin planning for the construction of the plant. P&ID shows how industrial process equipment is interconnected by a system of pipelines. P&ID schematics also show the instruments and valves that monitor and control the flow of materials through the pipelines.

This figure depicts a small and simplified PEFS or P&ID:



Advantages of PEFS:

The process flow chart provides a visual representation of industrial process equipment interconnected by a system of pipelines. It has the following six advantages.

- Gives everyone a clear understanding of the instrument process
- Represents the sequence of all relevant operations occurring during a process and includes information considered desirable for analysis
- Help to identify the scope of the process
- Presenting events which occur to the materials
- Incorporates specifications, standards and details that go into the design
- Facilitate teamwork and communication
- Shows graphically the arrangement of major equipment, process lines and main control loops
- Improves utilities which are used continuously in the process

- Digs into all the gory details about materials of construction

Process Safety Flow Scheme (PSFS):

The major objective of process safety management (PSM) of highly hazardous chemicals is to prevent unwanted releases of hazardous chemicals especially into locations that could expose employees and others to serious hazards. An effective process safety management program requires a systematic approach to evaluating the whole chemical process. Using this approach, the process design, process technology, process changes, operational and maintenance activities and procedures, non-routine activities and procedures, emergency preparedness plans and procedures, training programs, and other elements that affect the process are all considered in the evaluation.

Process Safety Flow Scheme is the diagram obtained after incorporating the safeguarding philosophy features in PEFS and ensuring that safety is imparted to the maximum possible level.

5. Conclusion

Comparison that shows the differences between a PFS and PEFS:

Description	PFD	P&ID
Used for Construction?	No	Yes
Shows all process and service piping?	No	Yes
Indicates presence of all controls?	No	Yes
Shows all motors?	No	Yes
Shows thermal insulation?	No	Yes
Shows major equipment?	Yes	Yes
Shows flow quantities?	Yes	No
Shows stream compositions?	Yes	No

This is the most revealing distinction. The P&ID on a job site is probably one of the most used documents. Everyone working on piping has one in pocket, and it is constantly spread out during discussions. PFDs, on the other hand, are never seen on a job site. They are available, in the files, but not used.

The PFD is a drawing needed early in the project. Indeed, the PFD is the most important drawing while the mass balance is being prepared. Later, the PFD guides the preparation of the P&ID. Finally the P&ID supplants the PFD, totally eclipsing it.

Both PFDs and P&IDs can be characterized as

- Communication tools
- Records
- Aids to thought processes

And PSFS is the desired outcome for any project after implementing safeguard features in the PEFS.

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