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Design Stages and Service Responsibilities





Contents

1 What is “Process Design”	3
2 Design Stages.....	4
3 Elements of the Design Phases	6
4 The HAZOP (Hazard and Operability) Study Exercise	7
5 Review of Drawings or Design by Others	9
6 Commissioning	10



ASK Pearcey Ltd provides consultancy advice and **process** design relating to industrial air pollution control applications.

This guide is a description of the various terms of our engagement with our customers and will hopefully clarify what can be expected at the various levels of service we provide.

1 What is “Process Design”

For ASK Pearcey Ltd, the term process design refers to the specification or generation of information regarding parameters of an air pollution control process. When a system is “designed” there are a number of engineering disciplines involved and some of which overlap in certain areas.

Typically a system will require **electrical** and **controls** engineering input, **mechanical** design (selection of materials of construction, design of vessel walls and support structures, physical positioning of equipment and associated spatial mechanics e.tc), **civil** design (determination of suitability of structural base of equipment location supporting of structures).

No single engineering discipline covers the “design of a system” on its own.

The process design is usually the determination of the size of certain equipment and the operating conditions that are likely to prevail.

As an example, a chemical scrubber will have the following typical process calculations and objectives:

- Type and height of packing
- Column diameter
- Recirculation rate of any scrubbing liquor
- Type and quantity of any chemicals used – including dosing rates
- Pressure drops across the system (gas side and liquid side)
- The rate of liquid purge from the system
- The heat of reaction/solution occurring as a result of its operation
- The rate of water evaporation
- The mass balance of contaminant (gaseous or otherwise) across the system
- Size and type of recirculation pumps
- Size of reagent storage tanks
- Control philosophy for system
- Process and instrumentation diagram for system
- HAZOP assistance
- Produce commissioning protocols
- Carry- out commissioning within a team or single handed (depending on job size)

Other engineering disciplines will then typically determine aspects including but not limited to the following:

- Refined column size to fit in with manufacturing limitations or transportation requirements



- Materials of construction for the column and internals
- Sizing of bunds for chemical storage and scrubbers
- Support structures for vessels, ducting and instruments
- Design the control panel and route the wiring
- Select the type of instruments required to meet the demands of the control philosophy
- Manage the installation and erection of the equipment
- Calibrate and test instrumentation
- Test and prove the control panel
- Produce the FDS for the system based on the Control Philosophy
- Determine concrete base size and utility positions
- Determine size of drainage and other services to the system
- HAZOP assistance
- Produce commissioning protocols
- Carry- out commissioning within a team or single handed (depending on job size)
- Develop their aspects of the operational and maintenance instructions

Whilst the process aspect of the projects that we are typically involved in is significant, a project cannot successfully progress without cooperation and engineering design input from other disciplines.

2 Design Stages

ASK Pearcey operate to 3 key stages of design as follows:

Conceptual Design

Basic advice, ideas and process flow diagrams generated to provide an indication of what might be required to achieve an air pollution target or what might be successful in upgrading an existing system. Conceptual design may require some basic calculations.

Conceptual Design is NOT intended for Construction
Conceptual Design or advice is provided *without prejudice* and is without liability for ASK Pearcey Ltd





Preliminary Design

A rudimentary or structured design which contains specifics to the application under consideration. This may include advice which can be acted upon without further input from ASK Pearcey. Preliminary designs are open for review and may have elements of full and final design features. This level of design will allow customers to develop budgets or quotations.

Preliminary Design is NOT intended for Construction



Detailed (Pre and Post HAZOP) Design

Detailed design represents design work that generates parameters and specifications that relate specifically to the process which is intended to be installed on site. It develops the final solution to resolve that application. All Detailed design work, in particular process and instrumentation diagrams MUST be subjected to a HAZOP before any construction begins.

Detailed Design is required for Construction phase and must be subjected to a HAZOP which ASK Pearcey Ltd attend



3 Elements of the Design Phases

Each of the design phases will have typical basic elements and these are exemplified below:

1/ Conceptual designs:

- Site visits and assessments with subsequent reports/conclusions
- Basic equipment sizes and sketches
- An outline process flow diagram
- Some indicative capital, operational or whole life costings
- Basic advice on Best Available Technique (BAT)
- Basic mass flow/balance diagram
- Legislative documentation (e.g. OMPs)

2/ Preliminary Designs:

- Equipment type selection and sizing with chemical/utility consumption rates
- Basic peripheral equipment sizing (e.g. fans and pumps)
- Extraction philosophy
- PFD for the process with basic instrumentation
- Advice on upgrading of existing abatement equipment
- Basic capital and operational costings
- Basic Process and Instrumentation Diagram

3/ Detailed Designs:

- Specific and detailed P&IDs for approval
- Detailed mass/heat balance
- Detailed process calculations to size equipment and extraction system
- Detailed pressure drop analysis
- Details of irrigation distribution systems, tanks dimensions, nozzle plans and other detailed specifics
- Review of general arrangements, instrument schedules and other documentation, by others, for approval
- Control philosophy
- Commissioning schedules/protocols
- Attendance and reporting of HAZOPs and associated actions

In section 1 of this document we highlighted the various engineering disciplines that are typically involved in even small projects. It is imperative that the end user or possibly the main contractor for any given project brings together these engineering disciplines to collate the “system design”.

Note that ONLY Post HAZOP design is valid for construction for ASK Pearcey Ltd Design input For this very reason.

Any document marked otherwise or, indeed unmarked in **design status** is NOT fit for construction.



Fit for Construction means “that the process design can be acted upon by other engineering disciplines to produce the necessary drawings and documents to facilitate construction”. No process design equipment sketch is fit for construction directly, even if marked POST HAZOP or with the “Not For Construction” label removed.

4 The HAZOP (Hazard and Operability) Study Exercise

According to the Health and Safety at Work Act 1974 (HASAW) and for Major Hazardous processes COMAH (1999) regulations, it is the responsibility of the **OPERATOR** or end user to identify risks associated with a plant.

There numerous regulations and protocols to refer to (example see HSE website: <http://www.hse.gov.uk/comah/sram/index.htm>) but in our view, the End-User or operator of the plant must facilitate and attend a HAZOP for the plant as a minimum and must fully discharge their responsibilities under HASAW and where appropriate, COMAH.

A HAZOP is a study and NOT a document. Any HAZOP documentation is a product of a HAZOP study.

The HAZOP study should include but not be limited to a team of individuals with responsibility within the project to be studied as follows:

- An electrical engineer
- A control/software engineer
- A mechanical engineer
- A process engineer
- An operator (as in person who will be physically operating that plant)
- Project manager(s)
- Engineers relating to specific plant items (e.g. a representative from a reactor manufacturer)
- Persons in positions of responsibility for the End User
- Persons in positions of responsibility for the Principal contractor
- Persons in positions of responsibility for the Planning Supervisor
- An independent chairperson
- An independent scribe

The HAZOP centres around the “frozen” process and instrumentation diagram (P&ID). It is a rigorous, painstaking and methodical study of each and every line within the P &ID diagram (referred to as “nodes”). Each node has a list of guide words applied to it and each guide word has a list of deviations applied to it in turn.

Example:

Guide word is “Flow”

Deviations maybe :



“reverse”
“None”
“misdirected”
“Less than”
“More than”

Each application of a deviation will generate scenarios, discussion, questions about the risk and consequence of the deviation and at each stage the plant is questioned for its robustness and suitability to prevent, minimise or handle such deviations. This in turn generates actions for individuals present to rectify any perceived flaw or weakness in the design.

We have never encountered a HAZOP which has not changed the design in some manner and hence it is extremely important that a HAZOP is carried out.

A HAZOP may take some weeks to organise, some days to complete and some further weeks to sign-off any actions. The Actions may result in the change of the P&ID, operational instructions, drawings and design. A design cannot therefore be fit for purpose unless it has undergone a formally recorded and signed-off HAZOP.

ASK Pearcey Ltd cannot enforce a HAZOP, however our design documents will not be given “post HAZOP” status without a HAZOP and will therefore not progress to being “fit for Construction”.

ASK Pearcey Ltd have HAZOP procedures and guide tables to assist in a formal HAZOP studies. We have provided these to assist clients in facilitating HAZOPs. There are however companies and individuals who specialise in HAZOPs and indeed other Structured What-If Techniques (SWIFT) and they have fully contained database driven HAZOPs that include the procedures for issuing and signing off actions. We advise that end-users formally engage specialists to facilitate HAZOPs if they do not have the capability in-house.

The HSE also advise a HAZAN (for COMAH) is undertaken as part of the hazard identification process. This is a study of the severity of a hazard in the event the risk of the hazard is realised. In our experience, HAZANs are often not a formal, separate study but are split into actions for groups of individuals. It is advisable to fully explore the consequences of a hazard actually occurring as it may well significantly affect the methods of mitigation put in place. An example would be the potential for cross filling of sulphuric acid into a chemical tank containing sodium hypochlorite. In this event chlorine is formed and this is a highly toxic gas. At a HAZOP measures would be suggested to minimise the risk of the cross filling occurring. The HAZAN looks at what would happen to chlorine if it were formed and what consequences this would have. If the implications included certain multiple fatalities then the HAZOP actions may well be made even more robust and the “budget” for mitigation increased accordingly.

It should be noted that the “OP” part of HAZOPs is often left relatively unexplored (particularly when operators are not involved in the study) and another study known as an ALM (Access Lifting and Maintenance) can be useful in identifying and eliminating operational issues. ASK Pearcey Ltd are rarely asked to attend these studies despite the fact that we can usefully contribute to them. Of course Access, Lifting and Maintenance could be added as guide words to the HAZOP and probably without the need for deviations.



For complicated projects, especially those involving several stages of treatment and with numerous interfaces with other equipment, it is advisable to implement a HAZCOM. This is a “big picture” SWIFT technique which looks at a whole process rather than individual lines on a PID. The purpose of a HAZCOM is to identify hazards that may arise as a result of commissioning activities. The HAZCOM needs to involve representatives from any party involved in concurrent commissioning activities. It becomes particularly relevant when there is dependency between various parties during the commissioning phase.

ASK Pearcey Ltd have attended HAZCOM events and found them to be useful in raising awareness of concurrent commissioning activities and their associated hazards.

5 Review of Drawings or Design by Others

When ASK Pearcey Ltd review drawings or design by others we are not assuming liability for any flaws that design. ASK Pearcey Ltd will not review or take part in the review process of electrical or civil engineering drawings. These are firmly outside our field of expertise.

When asked to review mechanical drawings, ASK Pearcey Ltd will look for obvious disparities between the drawing information and design information provided by ASK Pearcey Ltd (or other process designers where appropriate). A mechanical drawing may not reveal all aspects of the construction of the design and hence it may not be possible to determine all flaws in the mechanical design of the system from any one drawing.

ASK Pearcey Ltd cannot guarantee to find every discrepancy in a mechanical drawing and hence cannot provide full approval of any drawing. The same applies to other design documents such as P&IDs and datasheets provided by others.

To be absolutely clear, ASK Pearcey Lt will not even look at aspects of mechanical including but not limited to:

- Vessel wall thickness
- Type or number of bolts
- Type size of hatches/Dished ends
- Compliance with PDE5500 or BS4994

We are not mechanical engineers and this is outside our field of expertise.

For materials of construction ASK Pearcey Ltd will contribute by raising concerns if our experience leads us to believe that an unsafe or inappropriate material is being utilised, however liability for that material selection will remain with the vendor supplying the equipment or the 3rd party designer and NOT with ASK Pearcey Ltd.

ASK Pearcey Ltd are often sent equipment literature for items such as fans, heaters, pumps, condensers and even instruments and then asked to “approve” them.

We cannot approve specific equipment and pass it fit for purpose. We can pass comment and make suggestions regarding aspects or features of the equipment to assist in selection but the suitability of the equipment for the specified duty is down to the vendor of that equipment.



ASK Pearcey Ltd, do, provide the specified duty and operating conditions for such equipment. It is our responsibility that the correct process parameters are put forward in specifying any equipment within our scope of design. Frequently there is limited process design information. It is our responsibility to make the end-user aware of risks associated with lack of data. We will also work with the end-user to develop “design Margin” i.e. flexibility and factors of safety within the process design to allow for error and “unknowns”.

ASK Pearcey Ltd will not accept liability for process performance where design information is unavailable and the corresponding areas of “flexibility” have been defined. The development of these areas of flexibility and design margin are our contribution to mitigation of the end-users risk.

There is NO substitute for information and we strongly advise that any end-user or Operator makes every reasonable effort and investment to gather as much process data as possible that relates to their air pollution issue so as to minimise areas of uncertainty and risk.

ASK Pearcey Ltd can optimise this data gathering exercise and provide a scope which would suit our process design requirements to an acceptable level of risk.

6 Commissioning

ASK Pearcey Ltd provide a commissioning service for air pollution control systems. This includes commissioning equipment designed and installed by others.

We adhere to the following basic philosophy:

1/ Develop a Commissioning Protocol/Schedule or Procedure Document.

This document acts as a detailed method statement as to what activities will take place, why they will take place and how they will take place. It will identify what the client needs to provide (e.g. Safe access) and what we will provide to carry out the activities.

This document should be approved by the end-user or at least our client prior to commissioning taking place.

Formal method statements and risk assessments will then refer to the commissioning schedule.

2/ Carry out the commissioning.

The commissioning activities will typically follow the basic approach outlined below:

- 1/ P&ID check – check all equipment and instruments and lines are correctly installed
- 2/ Equipment/ ducting and pipework integrity checks
- 3/ Supervise/observe leak tests (normally carried out by vendor)
- 4/ Pre-commissioning – motor direction and other preliminary checks
- 5/ “dry” commissioning – without any process fumes or chemical reagents
- 6/ “Wet” commissioning- full or partial treatment duty



Commissioning may be phased or continuous depending on resources available and project progress.

It is important that all stages identified in the commissioning schedule are sequentially signed off to minimise the risk of bringing the system into a point of no return scenario without it being fully proven.

Commissioning and the associated commissioning schedule can be critical to the successful and safe operation of the plant and as such ASK Pearcey Ltd deem these activities as been mandatory within our scope of responsibility. We will not accept responsibility or liability for plant commissioned by others, even if the design is by ASK Pearcey Ltd.

In our experience most commissioning activities require input from a number of key personnel and the commissioning procedure should be discussed in order to ensure that the commissioning activities can be adequately resourced. The level of resource varies from project to project.