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GP 48-04

Inherently Safer Design (ISD)

This Group Defined ETP has been approved by the GVP Safety and Operations for implementation across the BP Group.

**BP GROUP
ENGINEERING TECHNICAL PRACTICES**

Foreword

Inherently safer design (ISD) is a way of thinking differently from traditional hazard management. Instead of identifying hazards and adding layers of protection to prevent and minimise hazards, inherently safer design first challenges whether the hazard can be eliminated completely or reduced in severity.

This revision of Engineering Technical Practice (ETP) GP 48-04 includes the following:

1. Scope/applicability broadened from concept selection to apply to major projects and new technology and additionally it is recommended for smaller projects, modifications, and changes in existing operations. This prompted the title change.
2. ISD is clarified to address elimination of a hazard as well as strengthening the robustness of a layer of protection.
3. The original flowchart, modified slightly, continues to be the backbone of the document.
4. It is written to be more inclusive across all BP Operations.
5. Definitions have been revised to be consistent with industry definitions and other ETPs.
6. The ETP has been moved from Category 24 (Fire and Blast Protection) to category 48 (Processes and Procedures) to be in the same category with the other similar type Group Defined ETPs. The title has also been amended.

These changes were so extensive that revisions have not been indicated in the margin as is normal practice.

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1. Scope

This GP addresses:

- a. Strategies of inherently safer design.
- b. Application of these strategies in projects, new technology, facility modifications, and changes in existing operations.
- c. How hazard and risk studies support these strategies.
- d. Planning and conducting reviews focused on inherently safer design.

2. Normative references

The following referenced documents may, to the extent specified in subsequent clauses and normative annexes, be required for full compliance with this GP:

- For dated references, only the edition cited applies.
- For undated references, the latest edition of the referenced document (including any amendments) applies.

BP

Unknown Number	Selection of hazard evaluation and risk assessment techniques.
GDP-31-00-01	Assessment, prioritisation, and management of risk.
GP 48-01	HSSE Review of Projects (PHSSER).
GP 48-02	Hazard and Operability (HAZOP) Study.
GP 48-50	Major Accident Risk (MAR) Process.

Health and Safety Executive (HSE)

CHIP/CHIP3	Chemicals Hazard Information and Packaging for Supply Regulations 2002.
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3. Terms and definitions

For the purposes of this GP, the following terms and definitions apply:

BP Operations

BP Strategic Performance Units, Business Units, projects, facilities, sites, and operations.

Cause

Event, situation, or condition that results or could result directly or indirectly in an accident or incident.

Concept safety evaluation (CSE)

Preliminary assessment of major accident hazards, potential consequences, and likelihood of occurrence used to identify key control and mitigation requirements for design.

Entity (BP entity or Operating entity)

Whilst these terms are not used in this GP they have a specific meaning in OMS. If this GP refers to BP Operation it should be interpreted as BP Entity or Operating Entity when working to OMS.



Hazard

Condition or practice with the potential to cause harm to people, the environment, property, or BP's reputation.

HAZID

Technique of brainstorming used to identify potential hazards. HAZID studies are very broad in scope. HAZID is sometimes called a preliminary hazard analysis.

HAZOP

Systematic, qualitative technique to identify and evaluate process hazards and potential operating problems, using a series of guidewords to examine deviations from normal process conditions.

Layer of protection

Device, system, or action that is capable of preventing a postulated accident sequence from proceeding to a defined, undesirable endpoint.

Layer of protection analysis (LOPA)

Method for evaluating the effectiveness of protection layers in reducing the frequency and/or severity of hazardous events.

Lifecycle cost

Total cost of installation or asset, including capital expenditure, operating, maintenance, and decommissioning costs.

Major Project

A project that is required to comply with requirements of MPCP (E&P) or Pcp (R&M)

Risk

A measure of loss/harm to people, the environment, compliance status, Group reputation, assets or business performance in terms of the product of the probability of an event occurring and the magnitude of its impact. Throughout this Practice the term "risk" is used to describe health, safety, security, environmental, and operational (HSSE&O) undesired events.

Safeguard

Device, system, or action that would likely interrupt the chain of events following an initiating cause or that would mitigate loss event impacts.

Safety instrumented function (SIF)

Safety function with specified integrity level that is necessary to achieve functional safety by putting process to a safe state or maintaining it in a safe state under predefined conditions. SIF is implemented using SIS.

Safety instrumented system (SIS)

Instrumented system used to implement one or more SIF. SIS is composed of sensors, logic solvers, and final control elements. An emergency shutdown system (ESD) is a specific example of an SIS.

What if analysis

Scenario based hazard evaluation procedure using a brainstorming approach in which typically a team that includes one or more persons familiar with the subject process asks questions or voices concerns about what could go wrong, what consequences could ensue, and whether the existing safeguards are adequate.



4. Symbols and abbreviations

For the purpose of this GP, the following symbols and abbreviations apply:

Capex	Capital expenditures.
COSHH	Control of substances hazardous to health.
CSE	Concept safety evaluation.
CVP	Capital value process.
EA	Engineering authority.
ESD	Emergency shutdown system.
FPSO	Floating production storage and offloading.
HAZID	Hazard identification study.
HAZOP	Hazard and operability (study).
HP	High pressure.
ISD	Inherently safer design.
KO	Knockout.
LNG	Liquefied natural gas.
LOPA	Loss of protection analysis.
MAR	Major accident risk.
MOC	Management of change.
MSDS	Material safety data sheet.
OMS	Operating management system.
Opex	Operational expenditures.
PHSSER	Project health, safety, security, and environmental reviews.
SIF	Safety instrumented function.
SIS	Safety instrumented system.
SPA	Single point of accountability.
SPU	Strategic performance unit.
TR	Temporary refuge.



5. Philosophy

5.1. Intent

- a. The intent of ISD, as discussed in this GP, is to:
 1. "...Eliminate the hazard completely or reduce its magnitude sufficiently to eliminate the need for elaborate safety systems and procedures. Furthermore, this hazard elimination or reduction would be accomplished by means that were inherent in the process and thus permanent and inseparable from it". [1]
 2. Go beyond elimination or reduction of a hazard. It also applies to layers of protection. "In the broad sense, the strength of a layer of protection can be improved by features that are permanent and inseparable from that layer". [1]

Thus, ISD applies to the robustness of layers of protection or hazard barriers.

Note 1 Inherently Safer Chemical Processes, American Institute of Chemical Engineers, Center for Chemical Process Safety (CCPS), 1996.

- b. The ISD focus on elimination or reduction of hazards also applies to environmental hazards.

Application of ISD strategies results in:

- *Fewer inherent hazards*
 - *Inherent hazards have been identified, assessed, understood, and addressed.*
 - *Opportunities to minimise hazards at the source have been identified, considered, and implemented, if practical.*
 - *Probability of unwanted events has been reduced by approaches, such as increasing equipment integrity, reliability, and longevity.*
- *Optimal capital investment with view to minimising risks for lifecycle of facility.*
- *Practical risk management strategy to manage primary risk drivers*
 - *Risk management strategy has been developed and agreed upon with those who will implement strategy.*
 - *Effective and reliable combination of measures to implement the risk management strategy.*

5.2. Strategies

Approaches to ISD have been grouped into four strategies.

These strategies were defined by Kletz, IChemE, and IPSPG and have been included in Center for Chemical Safety Process (CCPS) texts. [1]

- a. Minimise - use smaller quantities of hazardous substances (also called intensification).
- b. Substitute - replace a material with a less hazardous substance.
- c. Moderate - use less hazardous conditions, a less hazardous form of a material, or facilities that minimise the impact of a release of hazardous material or energy (also called attenuation).
- d. Simplify - design facilities that eliminate unnecessary complexity and make operating errors less likely and that are forgiving of errors which are made (also called error tolerance).



These strategies were defined by Kletz and have been included in Institution of Chemical Engineers (IChemE), and CCPS documentation. [1]

These can also be expressed as four categories:

- *Fewer hazards.*
- *Fewer causes.*
- *Reduced severity.*
- *Fewer consequences.*

Tabulation of potential goals for each category has been constructed from previous experience and is presented in Annex C.

5.3. Capex versus Opex

The full lifecycle costs shall be considered in inherently safer design evaluations.

Historically, decisions may have had greater focus on minimising Capex than on Opex over the full lifecycle.

A focus on inherently safer design may increase Capex and decrease Opex.

An example of this is well completion tubulars. Many had to be replaced at great cost and risk, requiring simultaneous operations. This could have been avoided by originally using corrosion resistant materials at relatively little extra cost.

Early project decisions should have a strong operational presence to ensure that the operational costs are considered.

6. Application

6.1. General

- a. Application of ISD should include:
 1. Early setting of ISD goals/criteria and development of a plan.
 2. Early hazard identification.
 3. Continued focus on ISD strategies as conceptual choices are progressively made at overall development concept, system, and component level.
 4. Recognition of lifecycle impacts of alternatives if choices are being made.
 5. Articulating ISD delivery status at each stage gate.
- b. ISD strategies shall be applied in major project design and new technology development.
- c. BP Operations EA shall develop an ISD policy for facility modifications and changes in existing operations.

The application of inherently safer design strategies is most effective if a design is under development and the full range of opportunities exists to eliminate or reduce hazards. As design details are finalised, opportunities to eliminate hazards may no longer be available, and the focus turns to managing the hazards by adding layers of protection to mitigate the hazard.

Considering an operating asset, the opportunities to address hazards often include additional layers of protection and procedural controls. These engineered and procedural layers of protection cannot achieve the same level of inherent safety as elimination of the hazard, because the hazard does exist. This is illustrated in Figure 1.

