

HAZOP

Guide Words



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Rev.2

1. HAZOP

- **HAZOP** is the abbreviation of **HAZ**ard and **OP**erability Study. It was developed in the late 60's by ICI (Imperial Chemical Industries), a major British chemical company at that time, and became the third stage of their 6 steps hazard analysis procedure.
- **HAZOP** is a qualitative technique.
- **HAZOP** stimulates the participants to identify potential deviation of the original intentions of the project.
- **HAZOP** is carried out using some basic documents, typically P&I, Operating Instructions and the previous Hazard Study I and II.
- **HAZOP** is focused on the IDENTIFICATION of potential deviations. Discussions on how to solve identified complex problems ARE NOT carried out during the **HAZOP** meeting.
- The **HAZOP** participants are composed by a multifunctional team, which should not exceed 6 participants, in order to promote a productive meeting.
- Participants **MUST** have expertise in their acting field.
- The **HAZOP** Leader **MUST** have a proper qualification to conduct the **HAZOP** process.
- **HAZOP** meeting should not exceed 3 hours. The number of necessary meetings will depend on the complexity of the project.
- **HAZOP** meetings should be conducted in a comfortable and quiet room. During the meetings, no external interruptions should be allowed.

Very important: **HAZOP** is only a part of a company's Risk Management Plan. Although being a very powerful tool, **HAZOP is not the holy grail for process safety analysis**. Other methodologies should also be considered according to the complexity of the process.

The following pages bring a suggestion of templates and guide words that might be used during a HAZOP study.

HAZOP front page:

HAZOP - Hazard & Operability Study



Equipament:

Customer:

Project:

City/Country:

Nº Document:

Date:

Revision:

Documents analysed:

P&I - 002.005

Lista de Itens/Nós avaliados	Participants
1 - Tank X	
2 -	
3 -	
4 -	
5 -	
6 -	
7 -	
8 -	
9 -	
10 -	

IMPORTANT: The hazard analysis recorded in this document take into account the reasonably predictable events. Catastrophic and unpredictable events such as aircraft crashes, sabotage, dam failures, etc. are not considered.

HAZOP – register of deviations:

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Item/Node		Tank X						
Item	Guide Word	Causes for Deviation	Available Protections	Consequences		Corrective Actions	Who	When
				WITH Protection	WITHOUT Protection			
1.1	High FLOW							
1.2	Low FLOW							
1.3	No FLOW							
1.4	Reverse FLOW							
1.5	High LEVEL							
1.6	Low LEVEL							
1.7	High REACTION							
1.8	Low REACTION							
1.9	High PRESSURE							
1.10	Low PRESSURE							
1.11	High TEMPERATURE							
1.12	Low TEMPERATURE							
1.13	Static Electricity							
1.14	Wrong Place							
1.15	High CONCENTRATION							
1.16	Low CONCENTRATION							
1.17	Contaminants							
1.18	High VELOCITY							
1.19	Low VELOCITY							
1.20	Before/Too Soon							
1.21	Later/Too Late							
1.22	Tests							
1.23	Maintenance							
1.24	Normal Effluents							
1.25	Abnormal Effluents							
1.26	Noise							
1.27	Failure in Utilities							
1.28	Emergencies							

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Guide Words - Part 1

For all the LINES	Alteration in QUANTITIES	High FLOW	Pump running-off; high pressure on lines/equipment; leakage of lines/equipment; flow control instrument failure; relief valve opening; human error (wrong valve manoeuvring, wrong definition of set points, etc.).
		Low FLOW	Pump failure; lines partially blocked; vacuum in lines/equipment; presence of sediments or foreign objects in the line (including air); fouling; cavitation; leakage in lines/equipment; flow control instrument failure; human error (wrong valve manoeuvring, wrong definition of set points, etc.).
		No FLOW	Pump failure; lines totally blocked; high pressure in the destination tank; origin tank empty; presence of sediments or foreign objects in the line (including air); fouling; severe leakage in lines/equipment; flow control instrument failure; human error (wrong valve manoeuvring, wrong definition of set points, etc.).
		Reverse FLOW	Pump failure, syphon, high pressure in the destination tank; vacuum in the origin tank; flow control instrument failure; human error (wrong valve manoeuvring, wrong definition of set points, etc.).
	Alteration in PHYSICAL CONDITIONS	High/Low PRESSURE	Boiling; cavitation; uncontrolled chemical reaction; condensation; clogging; fouling; foam; gassing; implosion; explosion; external fire; water hammer; failure of pressure control instruments; leakage in lines and equipment; human error (wrong valve manoeuvring, wrong definition of set points, etc.).
		High/Low TEMPERATURE	Boiling; cavitation; freezing; uncontrolled chemical reaction; condensation; implosion; explosion; heat of dissolution or reaction; external fire; dead head pumping; failure of temperature control instruments; leakage in lines and equipment; human error (wrong valve manoeuvring, wrong definition of set points, etc.).
		STATIC ELECTRICITY	Friction between low-conductive materials; grounding failure; use of non-conductive shoes & uniforms; low ambient humidity; powder movement; presence of plastic pipes/equipment.
		WRONG LOCATION	Possibility of transferring/receiving materials to/from an unwanted location; possibility of heating/cooling to/from other equipment; possibility of pressure change to/from other equipment.
	Alteration on CHEMICAL CONDITIONS	Low/High CONCENTRATION	Change in the proportion of mixtures; leakages in lines/equipment; changes in the quality (concentration) of raw-materials; failure of volumetric control instruments; human error (wrong valve manoeuvring, wrong definition of set points, etc.).
		Presence of CONTAMINANTS	Intake of air, water, steam, oils, corrosive materials; materials coming from leakages or pressurized systems; change in quality (purity, toxicity) of materials; corrosion; entrance of foreign materials through manholes.
	Alteration in TEMPORARY CONDITIONS	Low/High VELOCITY	Unwanted change in product transference velocity; change in the speed of agitators, conveyors, mills, screens, dosing devices, valve openings/closure, etc.
		OCASION (Too soon, too late)	Unwanted change of the start/end of scheduled events.
Conditions of STAR-UP & SHUTDOWN	TESTS & COMMISSIONING	Flow & Pressure tests with inert materials; interlock testing; set-point tests; vacuum/pressure tests.	
	MAINTENANCE	Easy access for maintenance; decontamination of lines/equipment; height of valves; maintenance plan for critical lines & equipment; purges; ventilation; temperature insulation; presence of critical spare parts.	

HAZOP Guide Words

HAZOP - Hazard & Operability Study Guide Words - Part 2

Category	Guide Word	Description
For all TANKS	Low/High LEVEL	Overflow; pressure oscilation; failure of level control instruments; human error (wrong valve manoeuvring, wrong definition of set points, etc.).
	Low/High REACTION/MIXTURE	Foaming; runaway reaction; endothermy; exothermy; catalysed reaction; agitator failure; vortices; erosion, corrosion.
For all SECTORS	ENVIRONMENT	EFLUENTE COMPATIBILITY Potential reactions in drains, manholes, sewage, ventlines, bleed lines, chimneys, collector lines.
	NOISE	Motors in general; fans; compressors; hydraulic pumps; misaligned and/or misbalanced equipment; change in the operation condition of equipment.
	OTHER	Leakages due to corrosion; operational failure; instrument failure, accumulation of dust, gases or vapours in confined or difficult-to-reach places; easy access for cleaning and/or decontamination.
	EMERGENCIES	UTILITY FAILURE Partial or total failure of electrical power, steam, vacuum, compressed air, water, ventilation, cooling, heating, lighting, both individually and collectively.
	UNSCHEDULED EVENTS	Electrical storms; floodings; SPDA failure; external or cross-sectors communication failre; fire, explosions; need for evacuation.



The Autor

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