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HAZard & OPerability (HAZOP) Guidelines

Minimizing Risk, Maximizing Hazard Identification

An ioMosaic Corporation White Paper

"*Learning from experience is a lantern on the stern, illuminating the hazards the ship has passed through. It is essential to do so as we may come the same way again. However, we should also have a lantern on the bow, so that we can see the hazards that lie ahead…*

…HAZOP is a lantern on the bow"

Trevor A. Kletz

Jordi Dunjó, Ph.D.

dunjo.j.nh@iomosaic.com

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HAZard & OPerability (HAZOP) Guidelines

Jordi Dunjó, Ph.D.
ioMosaic Corporation
93 Stiles Road
Salem, New Hampshire 03079

Abstract

This paper provides concise and structured documentation to be used as a “guideline” when conducting Hazard & Operability (HAZOP) studies. It collects and summarizes key tables, figures, and checklists placed in chronological order according to the sequential phases that define the HAZOP Management System (HMS). These strategic illustrations, as well as their layout provide the key “ready-to-use” tools able to maximize the effectiveness of a HAZOP study.

A component of the ioMosaic Process Safety Office™ Suite is used for maximizing the HAZOP effectiveness performance and minimizing time and efforts. This component is called HAZOPtimizer™, and it is intended to perform Process Hazard Analysis (PHA) and Layer of Protection Analysis (LOPA).

Introduction

This paper illustrates the key tools (tables, figures and checklists) “ready-to use” for project managers and team leaders for conducting Hazard & Operability (HAZOP) studies in the process industry [1].

A component of the ioMosaic Process Safety Office™ Suite is used for maximizing the HAZOP effectiveness performance and minimizing time and efforts. This component is called HAZOPtimizer™ [2], and it is intended to perform Process Hazard Analysis (PHA) and Layer of Protection Analysis (LOPA).

The following figures illustrate the key HAZOP documentation and define the HAZOP Management System.

Table 1: Key Concepts and Definitions

Variable	Definition
Design Intent	Overall statement of what the process involves
Node	Process section where parameters are investigated from deviations of its design intent
Node Intention	Defines how the process is expected to be operated, only considering node equipment
Specific Parameter	Physical or chemical parameters of process materials
Generic Parameter	Other aspects of the design intent complementing specific parameters information
Parameter Intention	Range of allowable values for the parameter during process operations
Guideword	Simple words or phrases used to qualify or quantify the intention
Deviation	Departure from the node intention
Hazard	Deviation having the potential to cause damage, illness, injury, or other form of loss
Cause	Reasons why deviations may occur
Consequence	Effects of the occurrence of a deviation
Safeguard	Physical or procedural measures that will eliminate or minimize a potential hazard
Recommendation	Suggested actions to prevent, detect, control, or mitigate the scenario identified

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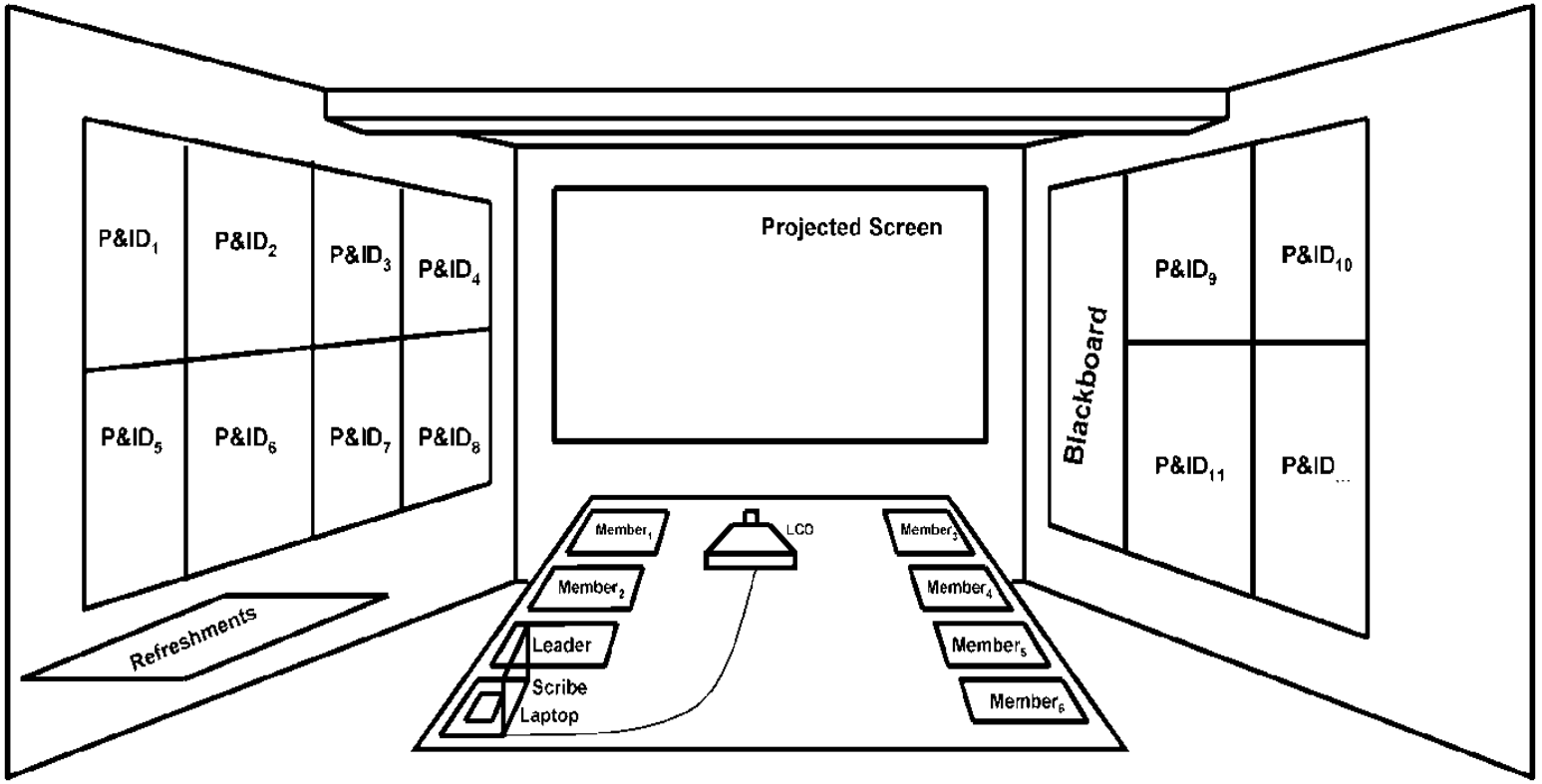
Table 2: HAZOP Management System

HAZOP Management System	Manager	Leader	✓	✗	Comments
First Phase. HAZOP Definition & Preparation					
1. Decide why and when to conduct a HAZOP study	■				
2. Ensure a well-matched Safety Management System (Information)	■				
3. Establish the PHA Software to be used (e.g., HAZOPtimizer™)	■				
4. Ensure the minimum HAZOP meeting room attributes	■				
5. Send project specifications to team leader candidates	■				
6. Appoint the team leader	■				
7. Define detailed purpose, scope and objectives of the study	■	■			
8. Select the appropriate HAZOP team by ensuring attendance	■	■			
9. Ensure the required information for conducting the study	■	■			
10. Establish risk ranking criteria	■	■			
Second Phase. HAZOP Definition & Preparation					
1. Selection of nodes		■			
2. Plan the study by arranging meetings	■	■			
Third Phase. HAZOP Execution & Documentation					
1. Generate deviations; i.e., Guidewords & Parameters combination		■			
2. Brainstorming sessions		■			
3. Report the study results		■			
4. Follow-up recommendations	■	■			

Table 3: Team Leader: Roles and Responsibilities during the whole HMS

Role	Definition
1	Address all key issues according to the scope, purpose, and objectives of the study
2	Ensure the study is completed within the expected time
3	Manage the team members and motivate the brainstorming
4	Ensure proper format of HAZOP worksheets; i.e., banner, columns, and column titles
5	Understand and explain to the team members the HAZOP particularities
6	Ensure worksheet entries are accurate, complete, and concise
7	Treat all realistic and significant deviations
8	Guide the team in determining the credibility of a cause, consequence, or safeguard
9	Lead the team on consistently assigning scenario risk levels; i.e., risk ranking
10	Meet and document HAZOP regulatory requirements in completing worksheets
11	Direct the team in properly formulating recommendations
12	Avoid legal and implementation problems by recording entries appropriately

Figure 1: Desired HAZOP Meeting Room Layout



Tools and Guidelines for Defining and Preparing HAZOP Studies

Table 4: Project Manager Roles and Responsibilities – Project Information

Project Information	Comments
Company name, facility, process and location	Identification of the process to be analyzed
Project manager identification	HAZOP responsible
Preliminary purpose, scope, and study objectives	Study requirements and definition

Table 5: Project Manager Roles and Responsibilities – Documentation

Required Information	Definition
Process Description	Detailed written description of process principal sections
Process Flow Diagrams (PFDs)	Relationship between major equipment of a plant facility
Piping & Instrumentation Diagrams (P&IDS)	Relationship between process equipment and control instrumentation
Plot Plan, Layout	Schematic description of the process equipment layout
Previous HAZOPs	Previous HAZOPs conducted on the same process
Corporate HAZOP Guidelines	Corporate criteria for conducting HAZOP (if exist)

Table 6: Minimum Team Leader Proposal Contents

ID	Required Information
1	Team leader identification and associated bio
2	Scribe identification and associated bio
3	List and description of potential nodes to be selected
4	Expected number of sessions
5	Criteria for planning the study: hours per session, sessions per week
6	Proposed HAZOP elapsed time

Table 7: Guidelines for defining HAZOP Studies

Guidelines for defining HAZOP studies	✓	✗	Comments
PURPOSE - Why the Study is performed?			
Meet regulatory requirements			
Meet industry requirements			
Meet corporate requirements			
Comply with good engineering practices			
Reduce legal liabilities			
Part of a post-incident investigation			
Comply with insurance company requirements			
Meet contractual requirements with customers or vendors			
SCOPE - What is included in the Study?			
1. Limits of the process properly determined; i.e., process boundaries			
2. Equipment involved that handle the covered chemicals			
3. List of utilities/services present in the process and under analysis			
4. Modes of operation included			
5. List of external events considered credible for the process			
6. Level of detail to be considered			
7. Exclusions; i.e., identification of what items are excluded from the study			
OBJECTIVES – What is to be Considered?			
1. HAZOP covers only major hazards associated with covered chemicals			
2. HAZOP includes other types of hazards from covered chemicals			
3. HAZOP includes hazards from non-covered chemicals			
4. HAZOP includes hazards from other process materials/equipment			
5. HAZOP focus on regulatory requirements			
6. HAZOP includes other issues of importance to the plant			

Table 8: Assessment of Hazards for defining HAZOP Guidelines

Assessment of possible hazards in process facilities	✓	✗	Comments
1. Covering Regulatory Requirements (Major Accidents)			
a. TOXIC RELEASE			
Addressing acute exposure and serious effects. Also including asphyxia			
b. FIRE			
Pool Fire			
Jet Fire			
Flash Fire			
Fireball			
Warehouse fires			
c. EXPLOSION			
BLEVE			
Rapid Phase Transition Explosion			
Vapor Cloud Explosions			
Detonations and Deflagrations			
Condensed Phase Explosions			
d. REACTIVITY			
Runaway Reactions			
2. Covering Other Types Of Hazards From Covered Chemicals			
Corrosives			
Skin irritants			
Lachrymators			
Others			

Assessment of possible hazards in process facilities	✓	✗	Comments
3. Covering Hazards From Non-Covered Chemicals			
Raw materials			
Intermediates			
Products and by-products			
Additives			
Catalysts			
Waste Streams			
Others			
4. Covering Hazards from other process materials/equipment			
Nitrogen asphyxiation			
Scalding from steam or hot oil			
Hot surfaces / materials			
Pinch points			
High pressures			
High Kinetic Energy			
Vacuum			
High Voltage / Current			
Others			

Table 9: Minimum HAZOP Team Knowledge

Expert Knowledge	Description/Value
Design Engineering	Knowledgeable on how the process is intended to operate Knowledgeable on applicable design standards, codes, specifications
Process Engineering	Knowledgeable on process science and technology Knowledgeable to judge the adequacy of existing safeguards
Operations & Maintenance	"Hands-on" operating and Maintenance experience
Health, Safety & Environmental	Knowledgeable of process hazards, safety systems, and related regulations
Other	Specialty areas

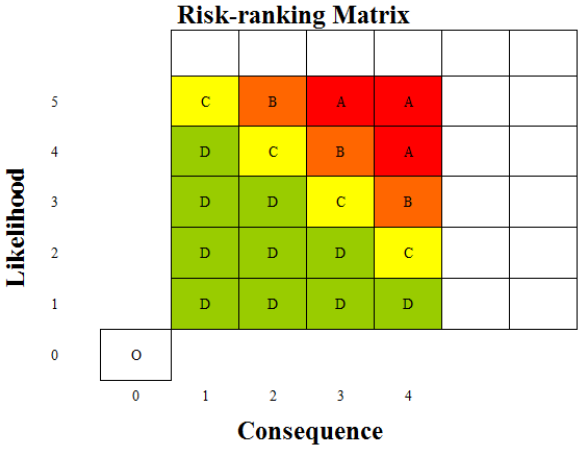
Table 10: Summary of HAZOP Members Roles and Responsibilities

ROLE	HAZOP MANAGEMENT STAGE	HAZOP EXECUTION STAGE	HAZOP DOCUMENTATION STAGE
HAZOP manager has to ensure all study stages are carried out with success, having into account both company and legal requirements			
MANAGER	To define the purpose, scope and objectives of the study To select the team leader To select the expert team To provide the required documentation To communicate the study plan To guarantee the required HAZOP meeting room	To ensure the attainment of the study requirements To ensure the responsibilities assignment	To ensure the final documentation quality To follow-up the recommendations
Site Coordinator is an optional role intended to support the HAZOP manager for ensuring well-suited sitting facilities, locations, equipment, etc.			
COORDINATOR	Liaison between team and HAZOP meeting room	To manage the team inside the work place To facilitate any required photocopy, etc. To manage the lunch logistics, refreshments, etc.	-
Team Leader' role is based on guiding the whole HAZOP. It is recommended that the team leader is not directly related to the company with the aim to ensure objectivity.			
LEADER	To analyze the required HAZOP documentation To subdivide the system into nodes To plan the sequence of work sessions To know legal requisites To ensure the documentation quality, quantity and deadline	To define the study to the team To explain the HAZOP technique to the team To guide the team on during HAZOP sessions To ensure the effective work of the team To maintain the control of the sessions schedule	To carry out the final study report
Scribe is an optional role intended to support the team leader on all HAZOP stages and document the information generated during HAZOP sessions			
SCRIBE	To provide technical support to the team leader	To document the generated information during sessions	To provide technical support to the leader
Expert team is a multidisciplinary group of professionals with different background with the aim to ensure a thorough review of the process			
TEAM	To claim the documentation with sufficient prior notice To analyze in detail the documentation received To have knowledge of the process to be analyzed	To be involved on the hazard identification stage To identify causes and consequences of scenarios To identify process safeguards To propose recommendations	To check the final documentation To evaluate the labor of the team leader To focus on solving recommendations

Table 11: Assessment of Required HAZOP Information

Assessment of required HAZOP information	Critical	Detailed	Useful	✓	✗	Comments
Information on hazards of hazardous chemicals in the process						
Material Safety Data Sheets		■				
Information on the technology of the process						
Process Description and Plant Operation	■					
Process Flow Diagrams (PFDs)	■					
Instrumentation and controls		■				
Maximum intended inventory		■				
Safe upper and lower limits for several process parameters		■				
Consequence evaluation of process parameters deviations		■				
Critical action list		■				
Diagrams describing operation modes		■				
Information on the equipment in the process						
Materials of construction		■				
Piping and instrumentation Diagrams (P&IDs)	■					
Electrical classification		■				
Relief system design						
Material energy balances		■				
Safety systems (interlocks, detection, etc.)		■				
Critical equipment list			■			
Other useful information						
Corporate HAZOP guidelines	■					
Plot Plan – Layout diagrams	■					
Information on previous incidents			■			
Information on services and utilities		■				
Relevant codes, standards and guidelines		■				
Skills of operating and maintenance personnel			■			
Cause and effects diagrams			■			

Figure 2: Risk Matrix (HAZOPtimizer)



Risk Level		Team Action
O	Operability	Operability issue
A	High Priority	Risk mitigation required to risk level "D"
B	Medium Priority	Risk mitigation required to risk level "D"
C	Low Priority	Risk mitigation required to risk level "D"
D	Very Low Priority	No further risk mitigation required

Levels of likelihood = 5
Levels of consequence = 4

Risk Ranking Consequence Ranges

high <-- low

Consequence Range	Safety Consequence Criteria		
1	First aid, Minor Environmental Release, PD & BI < $25,000		
2	Reportable Chemical Release, Recordable Injury, PD & BI < $100,000, minor fire		
3	LTI, PD & BI < $250,000, major fire, off-site release with public consequences		
4	One or more onsite or offsite fatalities, BI & PD > $250,000		
	Optional		

Risk Ranking Frequency Ranges

high <-- low

Likelihood Range	Event Frequency	Impact Frequency
1	$<10^{-4}$ (Once per 10000 years)	$<10^{-5}$
2	10^{-3} to 10^{-4}/yr (Once per 1000 years)	10^{-4} to 10^{-5}/yr
3	10^{-2} to 10^{-3}/yr (Once per 100 years)	10^{-3} to 10^{-4}/yr
4	10^{-1} to 10^{-2}/yr (Once per 10 years)	10^{-2} to 10^{-3}/yr
5	$>10^{-1}$/yr (Once per year)	$>10^{-2}$/yr

HAZOPtimizer™

*Risk-ranking matrix in HAZOPtimizer™ can be customized to match the users preferred risk matrix (i.e., matrix up to a 6x6).

Figure 3: ALARP Criteria (As Low As Reasonable Practicable)

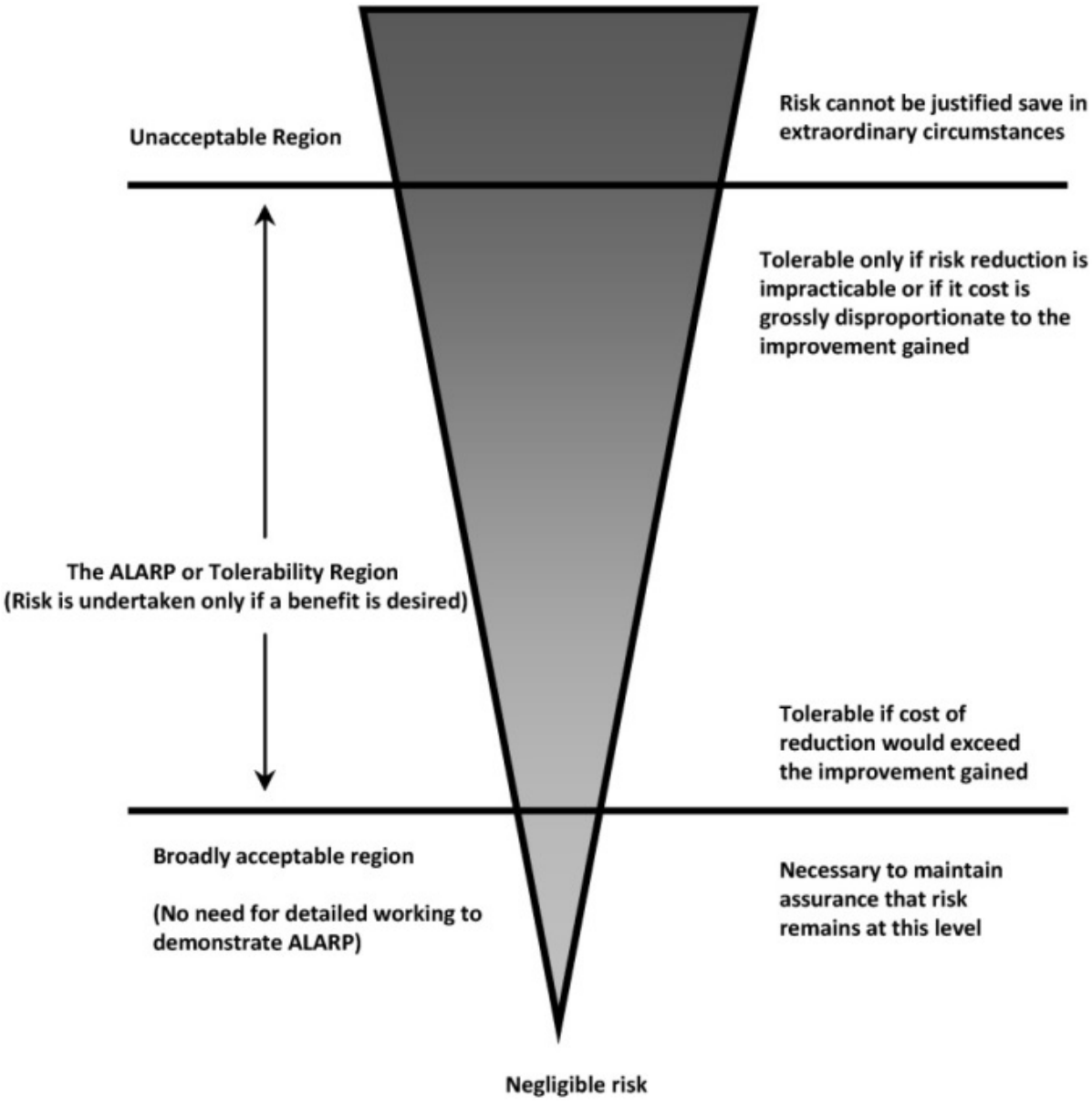


Figure 4: Process Nodes and Global Node Definition

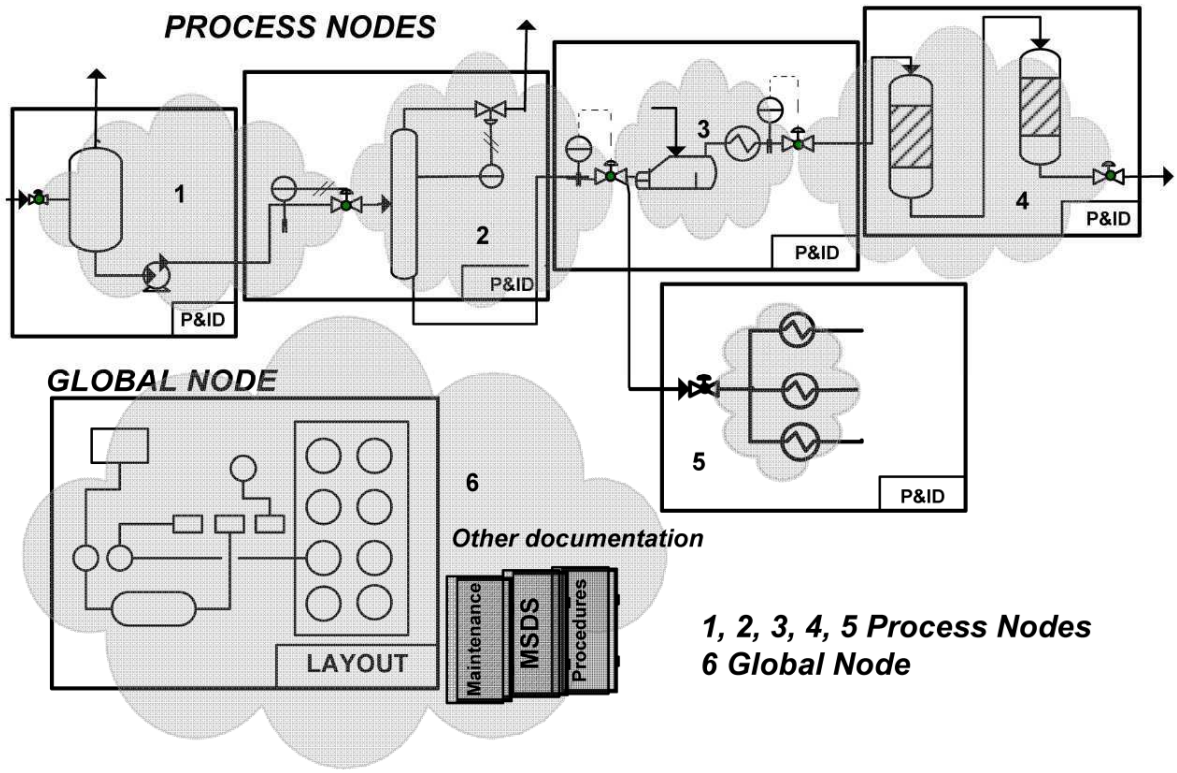


Table 12: Process Nodes and Global Node Definition

Documentation	Description
Process Description	Detailed written description of process principal sections
PFDs	Relationship between major equipment of a plant facility
P&IDs	Relationship between process equipment and control instrumentation
Plot Plan	Schematic description of the equipment layout
Previous HAZOPs	Consideration of previous HAZOPs carried out on the same process
*Internal HAZOP procedure	Corporate HAZOP guidelines to follow

*Not all companies have developed their own guidelines

Figure 5: Methodology for Selecting Nodes

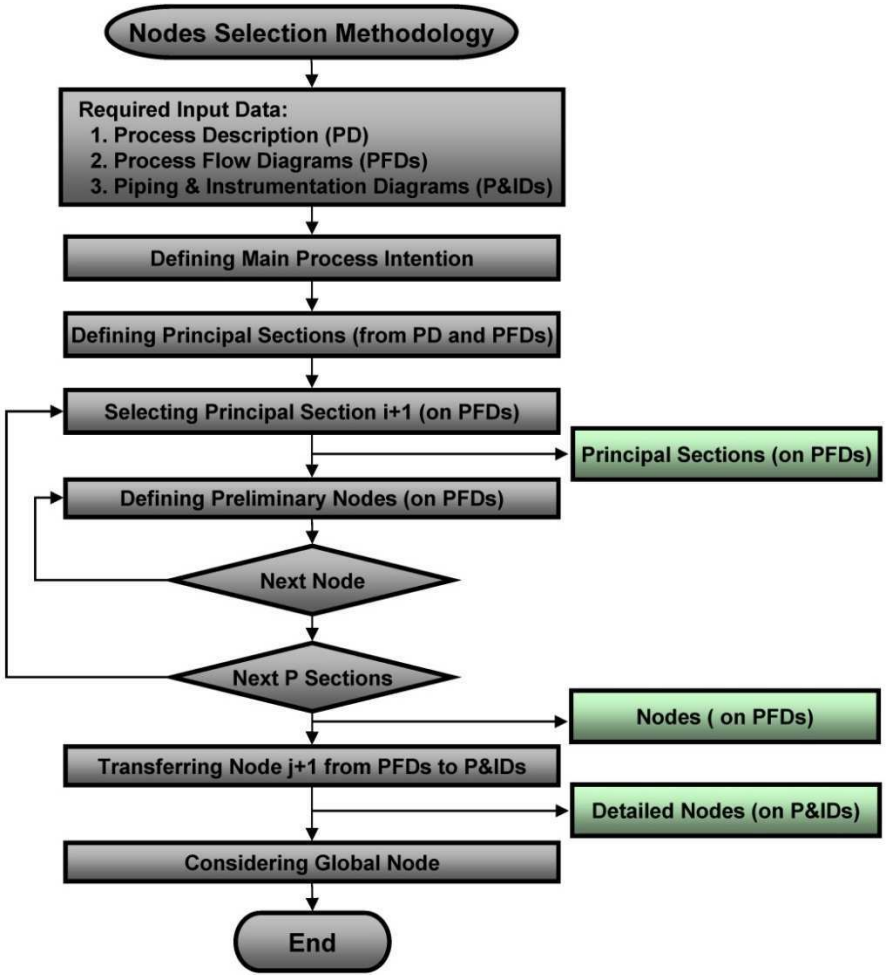


Figure 6: Sample Worksheet for Nodes Description

NODES	DESCRIPTION					SESSIONS	1	2	...	k
						Date (mm/dd/yy)				
	Design Intent	Boundaries	Process Conditions	Related Equipment	P&IDs Involved	Daily Schedule				
						Nodes involved	1	2, 3		n
1										
2										
3										
...										
n										

Figure 7: Example of Selected Principal Sections

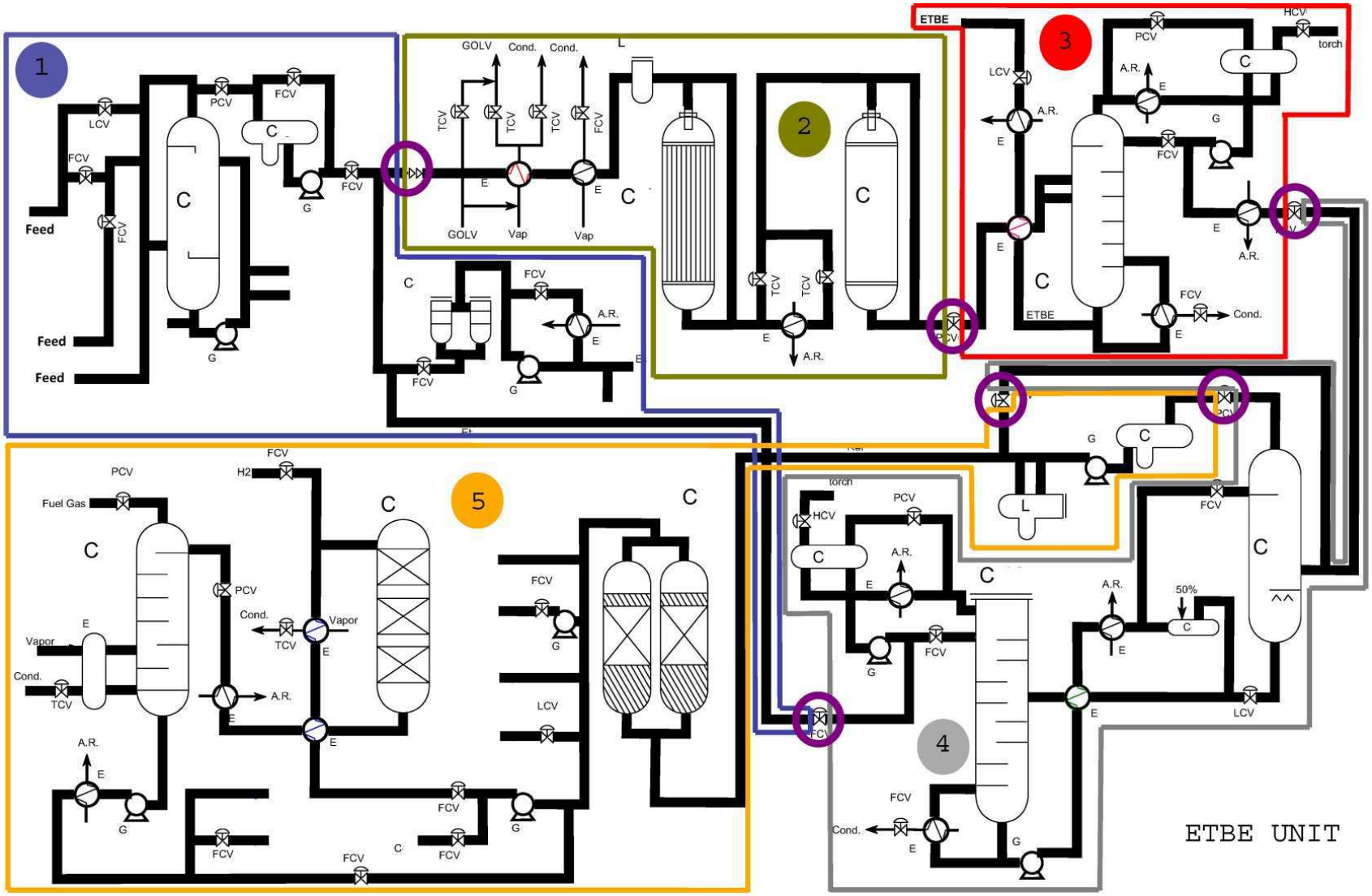
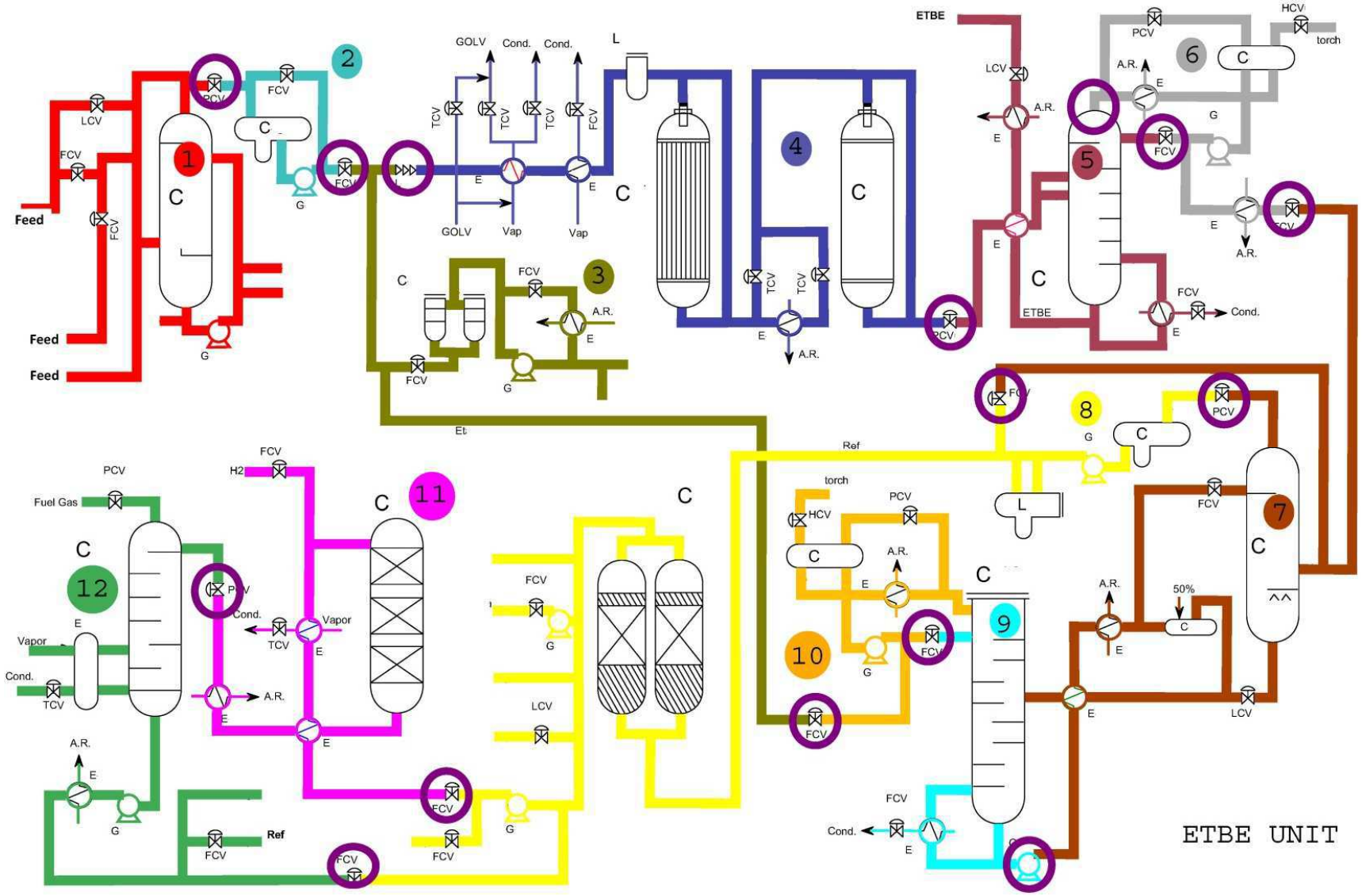


Figure 8: Example of Selected Process Nodes



Model for HAZOP Time Estimation

Table 13: Required Input Data and Model Results

Factors considered	Symbol	Input Data	Output Data
Number of P&IDs	X_1	■	
Number of Major Equipment	X_2	■	
Number of Nodes	N_d		■
Required Preparation Time (h)	T_P		■
Required Sessions Time (h)	T_S		■
Required Writing Time (h)	T_W		■
Number of sessions	N		■
Total Man Hours	MH		■
Total Elapsed Time (weeks)	T_H		■

Table 14: Criteria for Arranging HAZOP Sessions (Planning the Study)

Time (hours)	Time (weeks)	Considerations
T_P (h)	T_P (w) = 1/16 T_P (h)	4 hours per day; 4 days per week
T_S (h)	T_S (w) = 1/24 T_S (h) if $N_d > 9$	6 hours per session; 4 sessions per week
	T_S (w) = 1/30 T_S (h) if $N_d \leq 9$	6 hours per session; 5 sessions per week
T_W (h)	T_W (w) = 1/16 T_W (h)	4 hours per day; 4 days per week
T_H (h)	$T_H = T_P + T_S + T_W$	Sum of the total time predicted

Table 15: Required Input Data and Model Results

HMS actions included	Input Data	Model	Output Data
HAZOP definition, preparation and organization (T_P)			
Defining the purpose, scope and objectives of the study Selecting the appropriate HAZOP team Assembling and reorganizing HAZOP information Establishing risk ranking criteria Dividing the process into nodes Planning the study for arranging meetings	Number of P&IDs (X_1) Number of Major Equipment (X_2) Node selection criteria	$T_P = 0.698X_1 + 0.359X_2$	**T_P**
Number of Nodes, (N_d)			
Estimation of the number of nodes to be selected	Number of P&IDs (X_1) Number of Major Equipment (X_2) Node selection criteria	$N_d = 0.288X_1 + 0.508X_2$	**N_d**
HAZOP execution (T_S)			
Generating deviations – Guidewords & Parameters Brainstorming sessions	Number of nodes; $N_d(X_1, X_2)$	$T_S = 3(1+N_d)$	**T_S**
HAZOP documentation (T_W)			
Reporting the study results	**T_P**	$T_W = 0.40T_P$	**T_W**
HAZOP study time estimation (T_H)			
	T_P, T_S, T_W	$T_H = T_P + T_S + T_W$	**T_H**

Figure 9: Brainstorming Methodology Flowchart

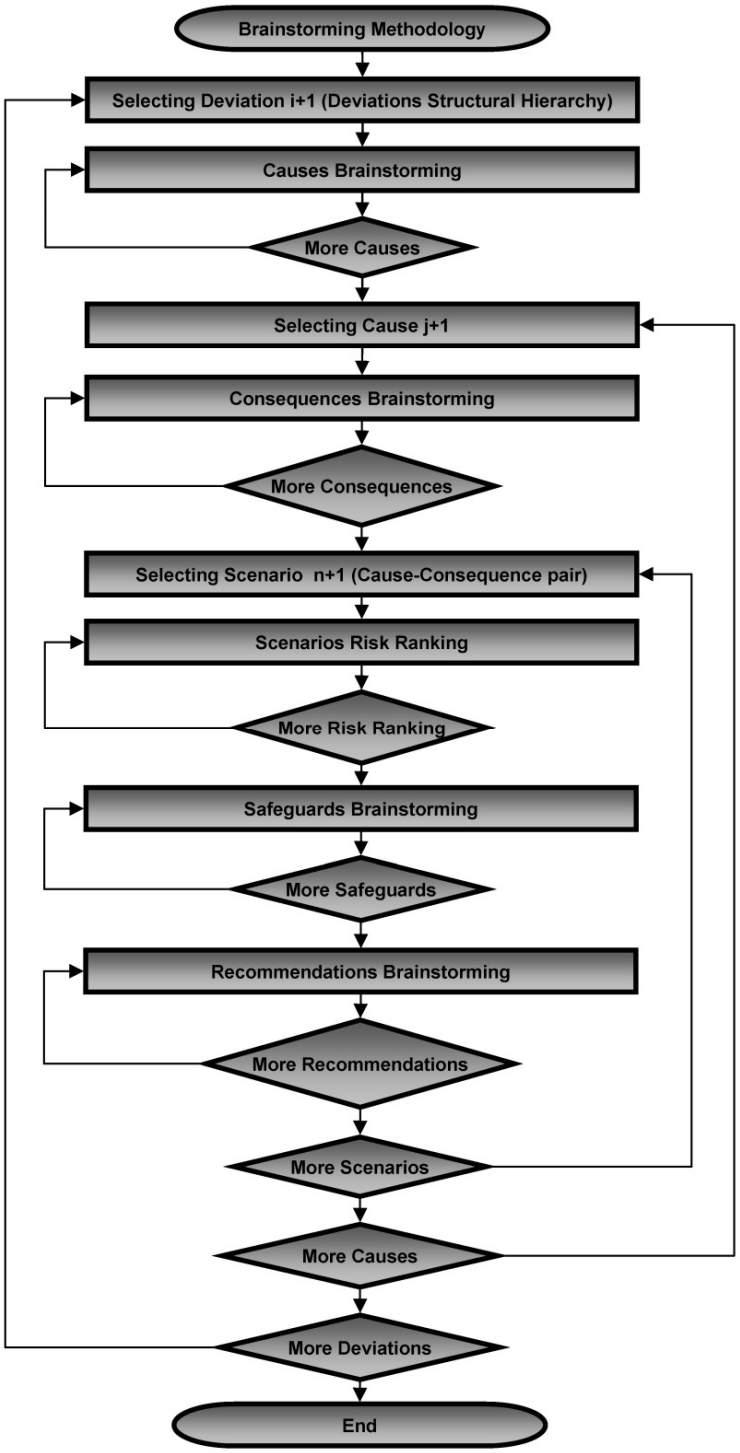


Table 16: First Brainstorming Session Duties

ID	First Brainstorming Session Duties
1	Introduce the team members themselves
2	Record attendance
3	Define the schedule, such as break times, daily timetable, and lunch time
4	Explain the HAZOP methodology to be applied during the sessions
5	Detail features of the software that will be used
6	Review the purpose, scope, and objectives of the study
7	Review the process to be analyzed
8	Check the available documentation
9	Mark and confirm the node subdivision
10	Consider the first node selected

Table 17: Deviations Structural Hierarchy - Process Nodes

Parameter	Guideword	Deviation	Meaning
LEVEL	More	More Level	High level with possible overflow. Flooding of pipes with inappropriate design for liquid phase fluid entries
	Less	Less Level	Low level with possible cavitation's' phenomena of pump systems connected after vessels. Additionally, the vessel could be totally emptied and remain without liquid, producing problems with equipment designed for drying conditions
FLOW	No	No Flow	No flow in locations where it was expected flow circulation
	Less	Less Flow	Restriction of the fluid flow. Often it is analyzed jointly with the "No Flow" deviation
	More	More Flow	Excessive flow in fluid transport piping systems than the expected
	Reverse	Reverse Flow	The fluid circulates in the opposite direction than the expected
PRESSURE	More	More Pressure	High pressure with possible hazards on the mechanical integrity of the node equipment if design pressure is exceeded
	Less	Less Pressure	Hazardous scenarios due to piping cavitation, blockage in vessels, etc. Risk of vessel implosions for equipment not designed for these conditions
TEMPERATURE	More	More Temperature	High temperature with possible thermal damage risk in construction materials or possibility of activating undesirable reactions
	Less	Less Temperature	Low temperature with possible risk of fluid freezing, construction materials embrittlement or undesirable crystallizations
COMPOSITION	Other than	Other than Composition	Presence of undesirable chemical substances by contamination or wrong addition (another product or impurities), by utilities access (water, oil, steam) and undesirable atmospheres generation (air)
PHASE	Other than	Other than Phase	Presence of a phase state (solid, liquid or gaseous) for which the process is not intented
UTILITIES	No	No Utilities	Unexpected utility failures. Experience highlights considering utilities as a specific deviation allows identifying hazardous scenarios not identified in previous deviations
OPERATION	As well as	As well as Operation	Analysis of other modes of operation than normal (start-up, shutdown, etc.). Valuable to treat carrying out Procedural HAZOPs for operations subjected under written instructions
CONTAINMENT	No	No Containment	Identification of any operative condition able to cause the emission of hazardous materials off-site: opening valves connected directly to the atmosphere as well as leaks through joints, or breakable mechanical elements
HUMAN FACTOR	As well as	As well as Human Factor	Determination whether all significant human failures have been identified by considering all the people who are involved, the various functions they may perform, the different types of mistakes they may make

Table 18: Deviations Structural Hierarchy - Global Node

Parameter	Guideword	Deviation	Meaning
UTILITIES	No	No Utilities	Utilities failure considering the whole unit. Experience highlights that this analysis allows identifying hazardous scenarios not identified in previous deviations
OPERATION	As well as	As well as Operation	Intended to identify modes of operation able to cause new hazardous scenarios overlooked in previous deviations. Valuable to treat carrying out Procedural HAZOPs for operations subjected under written instructions
CONTAINMENT	NO	No Containment	Identification of any operative condition able to cause the emission of hazardous materials off-site focusing the analysis as a “bird’s eye view”. Identification of direct ignition sources and specific locations where toxics leaks are possible
IMPLANTATION	As well as	As well as Implementation	Analysis of aspects affecting facility sitting: accessibility, get away routes, congestion equipment, vehicle impacts, drainage systems, slope, fire protection devices, facility location, process units spacing, spacing between equipment and potential ignition sources, domino effects, emergency response issues, hazardous area classifications
EXTERNAL EVENT	As well as	As well As External Event	Analysis of aspects away from process hazards which can cause hazardous scenarios regarding operational safety. Consider as minimum: lightning, flooding, deep cold, external fire and domino effect
HUMAN FACTOR	As well as	As well As Human Factor	Analysis of aspects focused on health and safety deficiencies of plant personnel as well as regarding the occurrence of major accidents caused for human failures in critical operations. Consider problems limiting personnel activities and emergency procedures

Figure 10: HAZOP Worksheet Example

Company:		**Drawing Numbers:**			
Facility:		**Unit/Process:**			
Date:	15-Jan-15	**Equipment and Lines:**			
Design Intention:					
	Level A: 0	Level D: 0			
	Level B: 0	Level : 0			
Study:	**HAZOP**	Level C: 0	Level : 0		Operating Issue: 0

Item No.	Deviation	Cause	Consequences	Engineering and Administrative Controls	L	C	R	Recommendations	Comments/ Questions	Action	Responsible
1.001	High flow										
1.002	No/low flow										
1.003	Misdirected Flow										
1.004	Reverse Flow										
1.005	Loss of containment										
1.006	High pressure										
1.007	Low Pressure										
1.008	Vacuum										
1.009	High temperature										
1.010	Low temperature										
1.011	Incomplete Reaction										
1.012	No Reaction										
1.013	Reactants added in wrong order										
1.014	Steps out of order										
1.015	High level										
1.016	No/low level										
1.017	Composition										
1.018	Startup										
1.019	Shutdown										
1.020	Emergency										
1.021	Contaminants or Impurities										
1.022	Material of Construction										
1.023	Sampling										
1.024	Corrosion/ erosion										
1.025	Effluent										
1.026	Service Failure										
1.027	Maintenance										
1.028	Facility Siting										
1.029	Human Factors										

HAZOPtimizer™

*HAZOP template can be customized to match the users preferred deviations structural hierarchy

Table 19: Guidelines for Treating Safeguards

ID	Guidelines for Treating Safeguards
1	Do not brainstorm if safeguards are present or not (if doubtful, add a recommendation)
2	If adequacy of safeguards is suspect, do not record it, but make a recommendation
3	Be specific when defining causes (e.g., using names, tag numbers, or other identifiers)
4	Be careful of taking credit for, or relying on human safeguards (e.g., procedures, experience, training)
5	Include all safeguards for the scenario whether within the node or not
6	When possible, record set-points (e.g., pressure relief devices, interlocks, alarms)
7	Consider safeguards organization according to the categories (prevention, detection, and mitigation)

Table 20: Guidelines for Treating Recommendations

ID	Guidelines for Treating Recommendations
1	Record an action if there is a breach of standards or the team unanimously agreed on a solution
2	Record a follow-up investigation if it is not obvious (not spend significant time)
3	Recommend further study of issues (e.g., more detailed risk analysis, conduct research)
4	Clearly define recommendations and unambiguously record them (e.g., third-parties understanding)
5	Consider qualifying recommendations with words such as “consider”, “verify”, “evaluate”, “review”, “study”, “investigate”
6	Ensure risk-reduction measures are practical and not introduce new hazards
7	Debate the value of a hierarchy of risk-reduction measures: elimination, prevention over mitigation, and passive over active
8	Favor administrative – and procedural – controls before engineered safeguards
9	Identify the person or department responsible (“By” Column) for each recommendation
10	Avoid worksheet entries that combine more than one recommendation
11	Address changes that result from recommendations in the next HAZOP re-validation

Conclusions

This paper provides concise and structured documentation to be used as a “guideline” when conducting HAZOPs; i.e., collection and summary of key tables, figures, and checklists.

All collected data has been placed in chronological order according to the sequential phases that define the HAZOP Management System (HMS).

The strategic illustrations, as well as their layout provide the key “ready-to-use” tools and criteria able to maximize the effectiveness of a HAZOP study.

A component of the ioMosaic Process Safety Suite™ is used for maximizing the HAZOP effectiveness performance and minimizing time and efforts. This component is called HAZOPtimizer™, and it is intended to perform Process Hazard Analysis (PHA) and Layer of Protection Analysis (LOPA).

References

[1] Dunjó, J.; "*New Trends for Conducting Hazard & Operability (HAZOP) Studies in Continuous Chemical Processes*"; Ph.D. Thesis Manuscript, 2010.

http://www.tdx.cat/bitstream/10803/6481/1/TJDD.pdf

[2] HAZOPtimizer™, a component of ioMosaic Process Safety Office™ Suite; ioMosaic Corporation, 2015.

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