

SPD0004ERN
PROCESS DESIGN MANUAL
HAZOP PROCEDURE

REV. : 4
DATE : 2013. 06. 25



SAMSUNG
ENGINEERING

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1.0 SCOPE

This project procedure defines requirements for Hazard and Operability (HAZOP) studies for all process plants, general facilities, storage and handling, utilities, other services and / or off-sites of the [project](#). This procedure can be implemented either at the FEED phase, detailed design phase or construction phase of the [project](#). SECL is responsible for ensuring that the actions raised during the HAZOPs are adequately addressed.

2.0 PURPOSE

The purpose of a HAZOP is to identify all possible deviations from which a design is intended to work and all the hazards associated with those deviations. It provides a structured review of the Piping & Instrumentation Diagram (P&ID) to:

- (i) Check the design and consider whether any of the deviations which may occur
- (ii) Check whether those deviations may cause a hazard / impact to personnel, to the general public to plant and equipment or to the environment.
- (iii) Check whether the safeguards incorporated in the design at the moment are sufficient to reduce any consequences to an acceptable level.
- (iv) If not sufficient, suggest additional safeguards.

3.0 DEFINITIONS AND ACRONYMS

The following definitions are relevant to this procedure:

HAZARD AND OPERABILITY STUDY (HAZOP)	Application of a formal systematic examination on the P&IDs to assess the potential for deviation from design intents and their consequential effects
CONSEQUENCE	A result of a deviation
DESIGN INTENT	The way in which the process and equipment is intended to work under both normal and anticipated abnormal conditions.
DEVIATION	A departure from the design and operating intention
GUIDE WORD	A word or phrase used to stimulate the HAZOP team to think about potential hazards and their causes
HAZARD	Materials and / or situations having the potential to cause damage, illness, injury or other form of loss
NODE	A defined section of process plant, general facilities, storage and handling, utilities, other services and off-sites to be examined
SAFEGUARD	Engineering or administrative measure that will eliminate or reduce the likelihood of a hazard occurrence and / or severity of consequence.

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4.0 RESPONSIBILITIES

The HAZOP study will be carried out by a multi-disciplinary team, the members of which should have sufficient experience and knowledge so that most questions can be answered on the spot. As a minimum the team shall be comprised of:

- Team Chairperson / Facilitator (To be provided by Client or SECL)
- Design Process Engineer (Client / SECL)
- Process Control/Instrument Engineer (Client / SECL)
- Licensor Representative (where applicable)
- Operations/Commissioning Representative
- Secretary

Note: In some organizations, the role of Process Engineer and Process Control Engineer may be covered by a single individual.

To ensure the quality, efficiency and effectiveness of HAZOP meeting, the HAZOP team members should be familiar with HAZOP methodology – at least two (2) times participation at HAZOP previously. In addition, introductory training on HAZOP methodology will be presented by HAZOP Chairperson / Facilitator at the beginning of HAZOP meeting.

4.1 HAZOP Chairperson / Facilitator

The success of the HAZOP study is dependent on HAZOP Chairperson / Facilitator experience in much the same way that the success of other types of meetings largely depends on the skill of the chairperson / facilitator. The HAZOP Chairperson / Facilitator will be selected by the HSE Manager (SECL or Client) based upon proven experience leading HAZOPS.

The role of the HAZOP Chairperson / Facilitator is to guide the study team through all the steps necessary to complete the study without unnecessary diversions. HAZOP Chairperson / Facilitator will encourage HAZOP team member to [propose](#) the division of the design into sections and ensures that all aspects of every part of the process plants, general facilities, storage and handling, utilities, other services and off-sites are covered and that each item is given due attention in relation to its importance. Where the details of significant vendor packages are unknown the completion of the HAZOP study will be highlighted for later action once details are obtained.

Prior to the schedule of meetings for the HAZOP of a specific plant, the HAZOP Chairperson / Facilitator will ascertain that all possible, relevant data is available from the respective process group, check that the team members are identified,

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briefed on their responsibilities and available in [accordance](#) with the schedule. See Attachment 6.7 for details on preparation. HAZOP Chairperson / Facilitator will ensure that an accurate and adequate record is maintained by the Secretary, especially of "action items".

HAZOP Chairperson / Facilitator must also ensure that all the specialists contribute according to their own expertise and that no individual dominates the discussion.

In the event of disagreement between the team members on controversial matters, the HAZOP Chairperson / Facilitator will decide what further action is required (e.g. Consult other specialists, define an action for SECL, and investigate further). The HAZOP Chairperson / Facilitator is responsible for the final editing and signing of the HAZOP Report.

4.2 HAZOP Team Secretary

It is important that clear and correct records of the HAZOP study are kept, that the report lists the hazards and operability issues identified, and that the recommended actions are clearly defined. The HAZOP Team Secretary should be familiar with HAZOP procedures, engineering terminology and the selected software. [She/he](#) fills in the work sheets as the study proceeds as directed by the HAZOP Chairperson / Facilitator.

The HAZOP studies will be conducted in the English language and therefore the HAZOP Team Secretary is required to have a good command of the English language.

4.3 Team Members

The remaining HAZOP team members should be suitably qualified and experienced and have a detailed knowledge of the way in which the design is intended to work.

The process engineer will attend at HAZOP full time basis. Other discipline engineers will participate in HAZOP on need basis.

5.0 IMPLEMENTATION

5.1 Procedure

Normally, the HAZOP Chairperson / Facilitator will divide the process (P&IDs) into several sections (nodes) in advance and each node will be studied one by one. At the start of the study, the Process Engineer will give an overview of the process/facility and how it is intended to operate. The workflow of HAZOP study is presented in Attachment 7.5 HAZOP Method Flow Chart and this chart can be

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followed in conjunction with the steps below. The documents that will be used for the HAZOP are listed in Attachment 7.7 Preparation for HAZOPS

Step 1

A node that will be studied will be selected.

Step 2

For each section (node) to be considered, the Process Engineer will need to briefly explain its function, which will be recorded in HAZOP work sheet.

Step 3

A process parameter should be selected. The standard parameters are listed in Attachment 7.2 Parameters

Step 4

A guideword should be selected. The standard guidewords are listed in Attachment 7.1 Guidewords. The selected guideword will be combined with the process parameter that is selected at Step 3 to develop the meaningful deviation. This developed deviation will be recorded into the HAZOP work sheet. Unreasonable combination of process parameters and guidewords such as “No Temperature” will not be considered.

Step 5

It should be checked what can cause the deviation that is developed from combination of process parameter and guideword. Any cause will be recorded as the cause of the deviation into the HAZOP work sheet. Possible scenarios for the deviation, which are provided in Attachment 7.4 Possible Scenarios Causing Deviations, can be referred to.

Step 6

It should be checked what are the consequences/hazards that the developed deviation can cause. The anticipated consequences/hazards will be recorded into the HAZOP work sheet.

Step 7

It should be checked whether there is any existing safeguard for the identified deviation and whether the existing safeguards are satisfied or not. The existing safeguard would be recorded into the HAZOP work sheet.

Step 8

In case that the existing safeguards identified at Step 6 are not satisfactory, additional safeguard will be developed. The additional safeguard can be engineering measures and/or administrative measures, which should be recorded as recommendation/action items into HAZOP work sheet.

Step 9

Return back to Step 4 and select another guideword. With this new deviation developed from new guideword, repeat Steps from Step 4 to Step 8 until all the guidewords are covered.

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Step 10

After all the guidewords are covered at Step 9, then return to Step 3 and select another process parameter. With new process parameter, repeat Steps from Step 3 to Step 9 until all the parameters are covered.

Step 11

After all the process parameters are covered for the selected node, return to Step 1 and select another node. With the new node, repeat Steps from Step 1 to Step 10 until all the nodes are covered.

5.2 Classifying HAZOP Actions

Significant actions raised during HAZOP reviews will be classified as High, Medium or Low risk according to the Risk Assessment Matrix shown below. This will enable management to prioritize follow-up.

HAZOPs also identify many items which are purely of an operability nature, where the use of the matrix will not be of value. The HAZOP Chairperson / Facilitator will decide into which category the actions fall.

RISK ASSESSMENT MATRIX

Severity	CONSEQUENCES				INCREASING LIKELIHOOD				
	People	Assets	Environment	Reputation	A	B	C	D	E
					Never heard of in industry	Heard of in industry	Incident has occurred in our Company	Happens several times per year in our Company	Happens several times per year in a location
0	No health effect/injury	No damage	No effect	No impact					
1	Slight health effect/injury	Slight damage	Slight effect	Slight impact					
2	Minor health effect/injury	Minor damage	Minor effect	Limited impact					
3	Major health effect/injury	Localised damage	Localised effect	Considerable impact	Low Risk				
4	PTD or 1 to 3 fatalities	Major damage	Major effect	National impact					
5	Multiple fatalities	Extensive damage	Massive effect	International impact		Medium Risk			
							High Risk		

Consequence = potential consequence of an incident

Likelihood = previous occurrence of this consequence due to this type of incident

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5.3 Documentation

After the HAZOP study is performed, HAZOP report will be prepared by the HAZOP Chairperson / Facilitator or HAZOP secretary.

The contents of HAZOP report will be as follows;

- General information about Project and Process
- Date/Duration and Attendee of the HAZOP
- General Note/Basis of the HAZOP that are considered during HAZOP
- List of HAZOP P&IDs
- List of HAZOP Node
- HAZOP Work sheet of each node (Design intents, Corresponding P&IDs, Deviations, Causes and Consequences of Deviations, Existing Safeguards and Recommendations for Additional Safeguards, etc.)
- Master P&IDs for HAZOP

The open/close-out status of the HAZOP recommendations will be managed using either the HAZOP report or separate summary sheet. And final HAZOP Close-out Report will be submitted to the Client after all the recommendations are addressed.

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6.0 REVISION HISTORY

Rev	Date	Page	Revision status
0	1996.01.22	All	- Newly prepared as HAZOP Procedure - Original Dept. : Process Engineering Team - Prepared by : Eui-Duk Lee - Approved by : Seok-Ho Yi
1	2004. 7. 1	All	- Revised as HAZOP Procedure - Original Dept. : Process Engineering Team - Prepared by : Henry Sung - Checked by : Jae-chul Ro, Jong-Heon Park, Eui-Duk Lee - Approved by : Chan-Sul Jung
2	2010.11.20	All	Document number revision Document number revision - Prepared by : D.S. Song - Reviewed by : H. Sung, J.C. Ro, H.H. Kwak, M.H. Oh, S.U. Hong - Approved by : E.D. Lee
3	2011.03.19	All	Revised as regular update - Prepared by : D.S. Song - Reviewed by : H. Sung, J.C. Ro, H.H. Kwak, M.H. Oh, S.U. Hong - Approved by : E.D. Lee
4	2013.05.31	All	Revised as regular update - Prepared by : J.H.YOO - Reviewed by : W.H. Cho, D.W. Kim - Approved by : S.B. Lee

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7.0 ATTACHMENTS

ATTACHMENT 7.1 - Guide words

7.1.1 Standard Guide words:

Guide Word	Meaning
No (not, none)	None of the design intent is achieved
More (more of, higher)	Quantitative increase in parameter
Less (less of, lower)	Quantitative decrease in parameter
As well as (more than)	An additional activity occurs e.g. the generation of static, other materials are present in addition to/in place of those desired e.g. additives, impurities
Part of	Only some of the design intent is achieved
Reverse	Logical opposite of the design intention occurs
Other than (other)	Complete substitution – another activity takes place eg. fluid solidifies instead of flowing.

7.1.2 Other useful Guide words:

Guide Word	Meaning
Where else	Applicable to flows, transfers, sources and destinations
Before/after	The step (or some part of it) is effected out of sequence
Early/late	The timing is different from the intention
Faster/slower	The step is done/not done with the right timing

ATTACHMENT 7.2 - Parameters

7.2.1 Standard Parameters:

Flow	Pressure	Temperature	Composition	Level
Phase	Operation			

7.2.2 Other Parameters to be considered:

pH	Viscosity	Particle size	Reaction	Transfer
Mixing	Stirring	Addition	Separation	Speed
Signal	Start/Stop	Operate	Maintain	Services
Communication	Time	Measure	Control	Sequence
Corrosion	Relief	Blowdown	Static	Sampling
Emergency	Spare equipment	Safety		

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ATTACHMENT 7.3 - Parameter guide word combinations

	No	More	Less	As Well As	Part Of	Reverse	Other Than
Flow	√	√	√	√	√	√	√
Pressure		√	√				√
Temperature		√	√				√
Composition					√		√
Level	√	√	√				√
Phase	√	√	√				√
Operation	√	√	√	√	√	√	√

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ATTACHMENT 7.4 - Possible Scenarios Causing Events

Guide word/Parameter Combination	Possible Scenarios Causing Events
NO Flow	Valve closed, wrong routing, blockage, blind flange left in, faulty non-return valve, filter blinded, burst pipe, air lock, failure of trace heating, water contamination in line freezes, flow transmitter/control valve malfunctions, pump or vessel failure.
LESS Flow	Partial blockage, vessel or valves failing, leaks, loss of pump efficiency.
MORE Flow	Control valve sticking open, flow controller malfunction, more than 1 pump operating, reduction in delivery head required, increased suction pressure, other routes, exchanger tube leaks.
REVERSE Flow	High pressure downstream/low pressure upstream, wrong routing, burst pipe, valve failure, emergency venting, pump or vessel failure.
AS WELL AS Flow	Sudden release of pressure causes 2-phase mixture. Overheating causes liquid/vapor mixture to form. Fracture of heat exchanger tube causes contamination by heating/cooling medium. Loss of interface in separation vessel. Ingress of air/water. Residual hydro-test fluid. Material passing through isolations.
LESS Pressure	Pressure control malfunction. RV relieves and fails to reseat. Pump-out rate exceeds capacity of vessel vent. Vessel vent blocked when emptying. Cooling in vessel allows vapor to condense. Blocked pump or compressor suction lines.
MORE	Pressure Surge, relief, leakage from HP connection, solar radiation on blocked-in line/vessel, pressure control malfunction, level control malfunction allows high pressure gas breakthrough, inadequate venting of air/vapor when filling.
LESS Temperature	Lower than expected ambient temperature/freezing, loss of pressure, loss of heating (including trace heating), failed exchanger tubes, temperature controller failure, pressure relief and cooling.

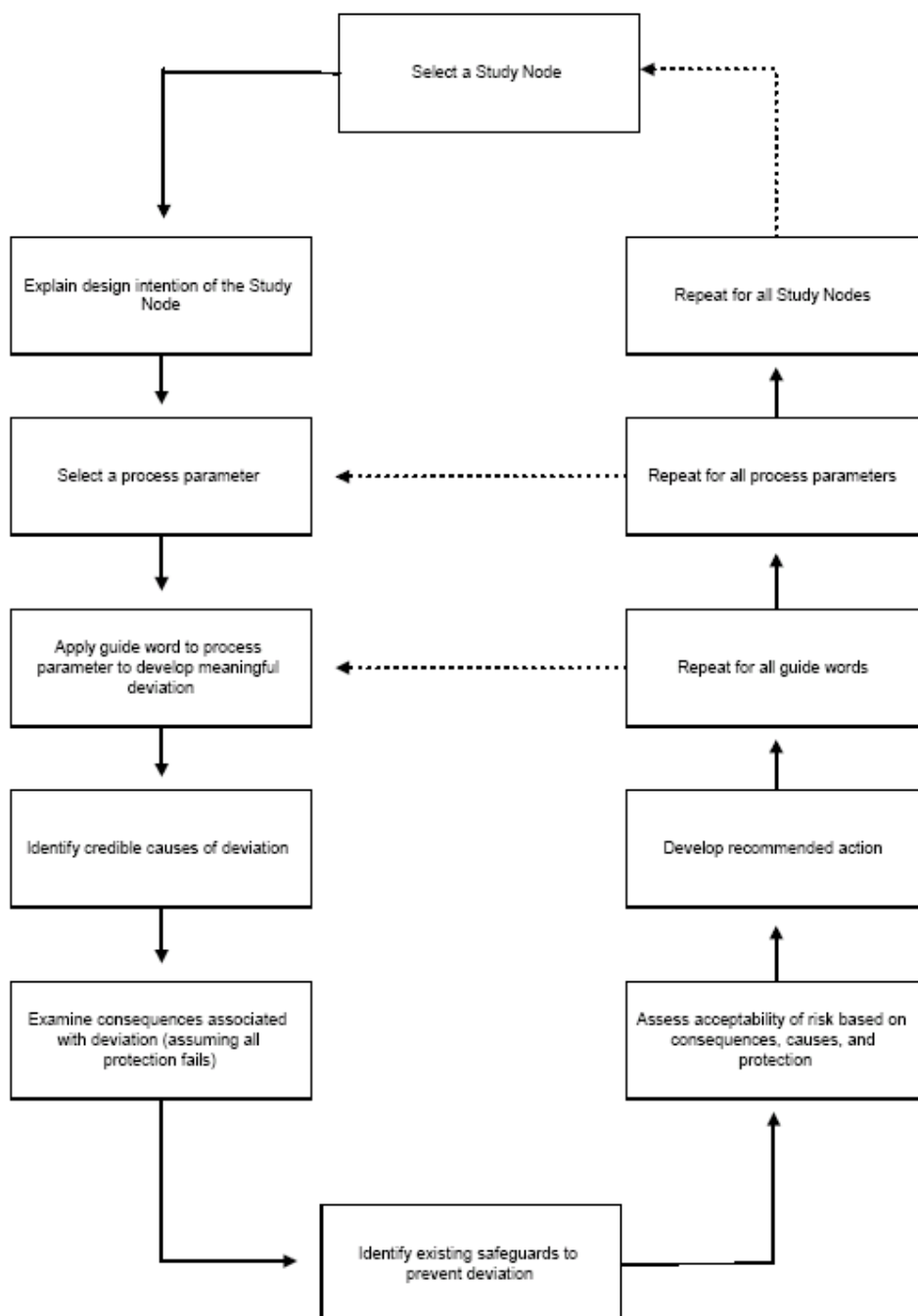
Guide

word/Parameter

Possible Scenarios Causing Events Combination

MORE Temperature	Temperature control malfunction, solar radiation, high ambient temps, fouled cooler tubes, cooling water failure, failed exchanger tubes.
MORE Level	Level control malfunction, control valve sticking shut, flow into vessel exceeds outflow capacity, flow impeded downstream.
LESS Level	Level control malfunction, control valve sticking open, drain valve passing.
PART OF Composition	Passing through isolations, leaking exchanger tubes, wrong feed material.
OTHER THAN Composition	Passing valve allows cross contamination, leaking exchanger tubes, incomplete upstream separation, corrosion products, low pressure allows gas breakout, precipitation or solidification, wax/hydrate formation, spalling of cement or other pipework/vessel linings.

ATTACHMENT 7.5 - HAZOP Method Flow Chart



ATTACHMENT 7.6 - Format For HAZOP Summary Report

A simple report can be combined with other material to produce a report to include:

- Front sheet
- Contents list
- Summary:

Explanation of purpose and outline scope of the study. Summary of main recommended actions and categorization summary i.e.

- flow sheet modifications
- actions for implementation by SECL in detail design
- actions for implementation by SECL during construction
- actions to be incorporated in plant operations/maintenance manuals
- other

- Introduction:

Background of the study, objectives/purpose, terms of reference, references to other work, timing, items covered and main items not covered by the study.

- Description of the Facilities:

Brief description of the facility or system under review including significant features of the design, operating and maintenance philosophies, arrangements for feed/product/utilities import/export.

- Discussion:

Discussion of main recommended actions if not covered adequately in the Summary.

- Recommendations:

Defined method of implementation of actions in line with above and recommended procedure to resolve outstanding issues.

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- Appendices:

- Team composition
- List of drawings reviewed/documents studied and revision status
- Meeting dates
- Report Sheets

The large size HAZOP master copy of documents reviewed by the team in the study sessions, marked-up and signed off by the Team Leader, will be stored and filed separately for reference.

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ATTACHMENT 7.7 - Preparation For HAZOPS

TECHNICAL INFORMATION

Project design basis

Process description

PEFS's for review

Report from previous Hazard/HEMP studies

Mass and heat balance

Logic diagrams and/or cause & effect diagrams

Electrical single line diagram

Site plan

Plant layout (plot plan)

Material safety data sheets

Process safeguarding narratives

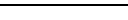
Process data sheets for major equipment

RV data sheets/summary of relief cases

Identification of Package Units (probably for later, separate HAZOP)

Process specific information as appropriate

- Exothermic reaction kinetics
- Flammable mixtures
- Unstable material
- Corrosion/metallurgy features
- Runaway reaction review reports

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Material specs/stds

Piping spec sheets

Ops & Maintenance Instructions (if available – maybe from existing unit)

(items in **BOLD** must be available)

HARDWARE NEEDS

Laptop

Facility for overhead projection and screen

Defined location and room

Power supply

Flip chart/white board and pens

Tea, coffee and drinking water

Large print size copies fixed to wall of frequently used reference

information e.g. Risk assessment matrix