Hazard Identification Studies (HAZID)

Service Title: Safety & Risk Management Services
Lead Practice: GL Plants & Pipelines (Germany)

Contents

Page 3 Service Description and Values Generated
Pages 4 - 13 Detailed Method Statement

The detailed method statements explain how the work is conducted, which inputs are required and which outputs and results can be expected.

a: Hazard Identification
b: Team Composition
c: Execution of the HAZID Sessions
d: Hazid Worksheet
e: Hazard Checklists

Pages 14 - 15 Case Studies and Examples

a: Natural Gas Cavern Storage
b: Maritime Oil Jetty in the River Danube
Service Description and Values Generated:

Motivation
The operator of a technical installation by which health and safety, the environment, assets and the operator’s reputation could be affected is obliged by European legislation to:

- have an up-to-date knowledge about all safety-relevant aspects of their operations,
- prevent accidents or to limit their impacts/escalations (as per the Seveso II Directive),
- control hazards reliably and to minimise risks by identifying installations with risk potential regarding health and safety as well as the environment, evaluating their inherent risks and specifying risk mitigation measures (which is part of the risk management process),
- design, start up, operate and maintain workplaces in such a manner that the workforce can conduct work without putting their own safety and health or that of others at risk.

Objectives
The objectives of the HAZID procedure offered by Germanischer Lloyd (GL) are to identify main hazards, to review the effectiveness of selected safety measures and, where required, to expand the safety measures in order to achieve a tolerable residual risk. In compliance with the Seveso II Directive, besides facility safety concepts for new installations, also safety concepts for existing operational facilities have to be reviewed.

The analysis serves the operator as proof that installations are operated such that hazards for employees, third parties, the environment and the surroundings can largely be excluded. The operator’s management gets an up-to-date picture of the present hazards and their possible effects.

By means of the HAZID analysis the primary process, but also non-process, hazards as well as their possible escalations can be identified due to the structured manner of the procedure. Employees can be advised of the relevant hazards concerning their working area. At the same time the outcomes can be taken as a support in compiling the required neighbourhood information. The facility designer considers the analysis results to improve safety concepts for new-built installations.

Frequency of Reviews
HAZID analyses are usually to be revised when considerable modifications, upgrades or re-design of existing facilities are carried out or if events like accidents, critical situations or near misses call for this. In this context a change, upgrade or re-design is to be considered as essential if process modifications associated with consequences for safety or safety related equipment are involved. This also applies for utilities including buildings, machinery, equipment etc. that do not necessarily contribute to the primary operating objective but which are associated with the process facilities in terms of layout or operation and that are safety relevant. Those being in charge of operations and those working in the facilities are obliged to indicate all identified possible changes. In principle operators are expected to repeat the analyses at least every 5 years in order to maintain the residual risk as low as reasonable practical.

Offered Service
The service offered in this matter is the provision of an experienced facilitator/chairman and a minute taker who guides through the HAZID sessions in a formal and consistent manner and captures the relevant results into the prepared HAZID spreadsheet. Subsequently upon completion of the sessions a report is prepared by the HAZID chairman and submitted to the client.
a. Hazard Identification

Hazard identification (HAZID) is “the process of identifying hazards, which forms the essential first step of a risk assessment. There are two possible purposes in identifying hazards:

- To obtain a list of hazards for subsequent evaluation using other risk assessment techniques. This is sometimes known as “failure case selection”.
- To perform a qualitative evaluation of the significance of the hazards and the measures for reducing the risks from them. This is sometimes known as “hazard assessment”.

During the hazard identification stage, the criteria used for the screening of the hazards will be established and possible hazards and accidents will be reviewed. For this purpose, the facility will be divided into several sections. Furthermore, the identified hazards will be classified into critical and non-critical hazards. It is of great importance that the hazards considered non-critical are clearly documented in order to demonstrate that the events in question could be safely disregarded.

This failure case selection will be executed by generating check lists, accident and failure statistics, hazard and operability Studies (HAZOPs) or by comparison with detailed studies and experience from previous projects.

The HAZID also includes the division of the plant into sections as mentioned above. An example of the section division is shown below:

<table>
<thead>
<tr>
<th>Area</th>
<th>Designation</th>
<th>Details</th>
<th>Flammable Inventory</th>
<th>Toxic Inventory</th>
<th>Comments/Others</th>
<th>PID/PFD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1st stage separator</td>
<td>1st separator, process area, lower deck</td>
<td>hydrocarbons</td>
<td>-</td>
<td>-</td>
<td>3000-T-02080841401C</td>
</tr>
<tr>
<td>2</td>
<td>Crude booster pumps</td>
<td>Crude booster pump, process area, lower deck</td>
<td>hydrocarbons</td>
<td>-</td>
<td>-</td>
<td>3000-T-02080841701C</td>
</tr>
<tr>
<td>3</td>
<td>Crude transfer pumps</td>
<td>Crude transfer pumps, process area, lower deck</td>
<td>hydrocarbons</td>
<td>-</td>
<td>-</td>
<td>3000-T-02080842001C</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1: HAZID section division. Example.

For each of the areas which contain toxic or flammable inventories, the details are compiled, also including potential sources of ignition.

The following sources provide further information on HAZID techniques:

- **CCPS (1992):** HAZID techniques in the process industries
- **CMPT (1999):** HAZID techniques for offshore installations
- **Ambion (1997):** HAZID techniques for offshore safety cases

The aim of the hazard scenario identification is the grouping of similar outcomes of different hazards.

Based on the facts compiled in the HAZID stage, the major hazard scenarios can be identified. Usually the hazard scenarios include release, fire, explosion and dispersion situations. Example: For the hazard (or initiating event) “small release”, the corresponding hazard scenarios are:

- BLEVE (Boiling Liquid Expanding Vapour Explosion), Fireball
- Escalation to large release fire
- Jetfire, no escalation
- Unignited release
b. Team Composition

The HAZID Study team shall neither be over nor undersized. Ideally the study is carried out by a team of 3 to 5 people plus facilitator and secretary. The team should be composed of the following participants:

- the design engineer in charge for the respective facility
- project manager (for new installations)
- plant engineer in charge
- maintenance engineer
- foreman/technician
- facilitator and minute taker

c. Execution of the HAZID Sessions

HAZID Session Preparation

Prior to the HAZID session itself the facility in question will be divided into manageable, logical sections (systems or units). Section limits can be identified for example where there is a significant change in the process conditions, a change in location or in material phase and composition. Sections will preferably be identified in a way that one section contains either gas or liquid, not both at the same time. Reasonable divisions of a complex facility can be processing units and less comprehensive facilities could also be sub-divided into functional groups. The identified sections will be written in the GLO section division document shown in Annex. This preparatory sectioning work including the compilation of the work sheets for each defined unit as well as the HAZID section division document is generally carried out by the facilitator. Subsequent to completion the prepared documents are subject to discussion with the operator’s representative.
d. HAZID Work Sheet

The HAZID work sheet within the HAZID workbook is divided into three steps:

**Step 1:** Hazard identification

**Step 2:** Risk estimation

**Step 3:** Recommended additional safety measures.

Step number one includes the columns “Determination of Hazards”, “Hazard Potential Determination”, “Progress of Escalation” and “Existing Safeguards”. The sections “Determination of the hazards” (Table 2) and the hazard checklist described in the next paragraph are interlinked. For example by typing “1” into the outermost left column of the spreadsheet, the hazard in the corresponding row of the hazard checklist will be adopted and automatically transferred into the next column of the HAZID sheet (in the example case it would be “Hydrocarbons under pressure”). The “assumed event” in the HAZID sheet will be the potential event from the hazard checklist described in further detail.

<table>
<thead>
<tr>
<th>Determination of hazards</th>
<th>Hazard potential determination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazards (1-18) s. Hazards checklist (letter/title)</td>
<td>Plant section/Individual Equipment (1,2,3...)</td>
</tr>
<tr>
<td>1 Hydrocarbons under pressure</td>
<td>1-3</td>
</tr>
<tr>
<td>3 Liquids and Gases under High Pressure</td>
<td>1-3</td>
</tr>
<tr>
<td>13 Safety Systems</td>
<td>1-3</td>
</tr>
<tr>
<td>14 MSR-Systems</td>
<td>1-3</td>
</tr>
</tbody>
</table>

Table 2: Excerpt from HAZID sheet: Step I - Determination of hazards.

Table 3: Excerpt from HAZID sheet: Step I - Hazard potential determination.
The next column includes the progress of the escalation. Here the possible escalating scenarios for the initiating event/hazard associated with the relevant plant sub-sections are described [Table 4].

The derived scenario originating from a gas leak might be an ignition followed by a fire (jet fire, pool fire). In the columns following to the right those technical and organisational safety measures already being in place are listed for each combination of initiating event and derived escalation [Table 5].

### Table 4: Excerpt from HAZID sheet: Step I – Development of escalation.

<table>
<thead>
<tr>
<th>Progress of escalation (1.1,1.2...)</th>
<th>Existing Safeguards</th>
<th>Technical Safeguards</th>
<th>Organisational Safeguards</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Subsequent Event/Encroachment onto other Systems)</td>
<td>Aim: Disable hazards, avert hazards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1-1.3</td>
<td>jet fire/pool fire, gas cloud formation, explosion</td>
<td>gas detectors, smoke detectors, deluge, isolation</td>
<td>maintenance according to operating manual</td>
</tr>
<tr>
<td>7.1-7.3</td>
<td>Fire</td>
<td>deluge</td>
<td>maintenance according to operating manual</td>
</tr>
<tr>
<td>13.1-13.3</td>
<td>BLEVE</td>
<td>passive fire protection</td>
<td>maintenance according to operating manual</td>
</tr>
<tr>
<td>14.1 +14.3</td>
<td>carryover of liquids into gas stream, damage of compressor</td>
<td>separators upstream of compressors</td>
<td>maintenance according to operating manual</td>
</tr>
<tr>
<td>14.1-14.3</td>
<td>pipe to flare fails to open, overpressure in vessel, rupture of piping, gas leak</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 5: Excerpt from HAZID sheet: Step I – Assignment of existing safety measures/safeguards.
In Step II a qualitative risk assessment for all derived scenarios is conducted. According to the beforehand agreed approach the risk estimation is applied to all four categories (i.e., persons, assets, environment and reputation) or just for one of them or a combination of these categories. In the case when the qualitative risk assessment is limited only to one category this is usually the category “persons”. The risk estimation is carried out by means of the 5 by 5 risk matrix which is also part of the HAZID workbook. Usually the scenarios should be completed line by line, i.e., before moving to the next scenario the risk estimation should be carried out rather than going through all scenarios and subsequently carrying out the estimation. Once the estimation is carried out by typing the relevant alphabetical combinations of probability of the event (A-E) and severity of the scenario (1-5) the corresponding cells in the HAZID spreadsheet are automatically colour coded in accordance to the referenced risk matrix when the macro button is clicked. This helps to more easily identify medium and higher risk scenarios. Cells within the risk estimation section that are not assigned an alphabetical combination remain blank.

Annex

<table>
<thead>
<tr>
<th>Determination of hazards</th>
<th>Assumed Event</th>
<th>Hazard potential determination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hazards (1-18) or, Hazards checklist</td>
<td></td>
<td>Plant sector/individual Equipment (1,2,...)</td>
</tr>
<tr>
<td>1 Hydrocarbons under pressure</td>
<td>1-3</td>
<td>17 bang</td>
</tr>
<tr>
<td>3 Liquids and gases under High Pressure</td>
<td>1-3</td>
<td>-</td>
</tr>
<tr>
<td>13 Safety Systems</td>
<td>1-3</td>
<td>-</td>
</tr>
<tr>
<td>14 MSR-Systems</td>
<td>1-3</td>
<td>-</td>
</tr>
</tbody>
</table>

HAZID-Worksheet - Risk Matrix

<table>
<thead>
<tr>
<th>Severity code</th>
<th>Consequences</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Personnel (SP)</td>
<td>Assets (SA)</td>
</tr>
<tr>
<td>minimal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>low</td>
<td></td>
<td></td>
</tr>
<tr>
<td>medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>high</td>
<td></td>
<td></td>
</tr>
<tr>
<td>very high</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

HAZID-Worksheet - Risk Matrix

<table>
<thead>
<tr>
<th>Description of the plant:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant section:</td>
</tr>
<tr>
<td>- Wet area</td>
</tr>
<tr>
<td>1. Evaporators</td>
</tr>
<tr>
<td>1.1 Evaporator 1</td>
</tr>
<tr>
<td>1.2 Evaporator 2</td>
</tr>
<tr>
<td>1.3 Evaporator 3</td>
</tr>
<tr>
<td>2. Evaporators</td>
</tr>
<tr>
<td>2.1 Evaporator 1</td>
</tr>
<tr>
<td>2.2 Evaporator 2</td>
</tr>
<tr>
<td>2.3 Evaporator 3</td>
</tr>
<tr>
<td>3. Evaporators</td>
</tr>
<tr>
<td>3.1 Evaporator 1</td>
</tr>
<tr>
<td>3.2 Evaporator 2</td>
</tr>
<tr>
<td>3.3 Evaporator 3</td>
</tr>
<tr>
<td>4. Evaporators</td>
</tr>
<tr>
<td>4.1 Evaporator 1</td>
</tr>
<tr>
<td>4.2 Evaporator 2</td>
</tr>
<tr>
<td>4.3 Evaporator 3</td>
</tr>
<tr>
<td>5. Evaporators</td>
</tr>
<tr>
<td>5.1 Evaporator 1</td>
</tr>
<tr>
<td>5.2 Evaporator 2</td>
</tr>
<tr>
<td>5.3 Evaporator 3</td>
</tr>
<tr>
<td>6. Evaporators</td>
</tr>
<tr>
<td>6.1 Evaporator 1</td>
</tr>
<tr>
<td>6.2 Evaporator 2</td>
</tr>
<tr>
<td>6.3 Evaporator 3</td>
</tr>
<tr>
<td>7. Evaporators</td>
</tr>
<tr>
<td>7.1 Evaporator 1</td>
</tr>
<tr>
<td>7.2 Evaporator 2</td>
</tr>
<tr>
<td>7.3 Evaporator 3</td>
</tr>
<tr>
<td>8. Evaporators</td>
</tr>
<tr>
<td>8.1 Evaporator 1</td>
</tr>
<tr>
<td>8.2 Evaporator 2</td>
</tr>
<tr>
<td>8.3 Evaporator 3</td>
</tr>
</tbody>
</table>
## Step II: Risk estimation

### Progress of escalation (1.1,1.2...) (Subsequent Event/Encroachment onto other Systems)

<table>
<thead>
<tr>
<th>Event</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1-1.3</td>
<td>Jet fire/pool fire, gas cloud formation, explosion</td>
</tr>
<tr>
<td>7.1-7.3</td>
<td>Fire</td>
</tr>
<tr>
<td>13.1-13.3</td>
<td>BLEVE</td>
</tr>
<tr>
<td>14.1-14.3</td>
<td>Carryover of liquids into gas stream, damage of compressor</td>
</tr>
<tr>
<td>14.1-14.3</td>
<td>Pipe to flare fails to open, overpressure in vessel, rupture of piping, gas leak</td>
</tr>
</tbody>
</table>

### Existing Safeguards

**Aim:** Disable hazards, avert hazards

<table>
<thead>
<tr>
<th>Technical Safeguards</th>
<th>Organisational Safeguards</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas detectors, smoke detectors, deluge, isolation</td>
<td>Maintenance according to operating manual</td>
</tr>
<tr>
<td>Deluge</td>
<td>Maintenance according to operating manual</td>
</tr>
<tr>
<td>Passive fire protection</td>
<td>Maintenance according to operating manual</td>
</tr>
<tr>
<td>Separators upstream of compressors</td>
<td>Maintenance according to operating manual</td>
</tr>
</tbody>
</table>

### Effects on

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1-1.3</td>
<td>4</td>
<td>B</td>
<td>3</td>
<td>B</td>
</tr>
<tr>
<td>7.1-7.3</td>
<td>2</td>
<td>B</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.1-13.3</td>
<td></td>
<td></td>
<td>4</td>
<td>B</td>
</tr>
<tr>
<td>14.1-14.3</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

---

### Form for completion

- **Name:**
- **Function:**
- **Date:**
- **Signature:**

---

### Created by: ______________

### Verified by: ______________

### Approved by: ______________

---

### Description of the plant:

- **Total 4 Flumes:**
- **Plant section:** Total stage separation.
e. Hazard Checklist

1. Hydrocarbons under pressure
   Examples: Natural Gas, Shallow Gas, Condensate, Crude Oil, LPG, Propane
   Conditions to Take Effect:
   Consequences of the Hazard - immediate / - escalating
   
2. Toxic Substances, Hazardous Materials
   Examples: H2S, Cl2, Smoke, HCl
   Example products: So2, HF, Benzol, CO2, asphyxiating gases, exhaust gases, intoxicating gases, hazardous waste, glycol, catalyst dust
   Conditions to Take Effect:
   Consequences of the Hazard - immediate / - escalating
   
3. Liquids and Gases under High Pressure
   Examples: injection water, instrument air/compressed air, steam, nitrogen
   Conditions to Take Effect
   Consequences of the Hazard - immediate / - escalating
   
4. Hot or cryogenic fluids
   Examples: Liquid Sulphur, Steam, pressure-liquidified Fluids, heating substances, cryogenic-liquidified Nitrogen
   Conditions to Take Effect
   Consequences of the Hazard - immediate / - escalating
   
5. Blasting Agents, Explosive Substances
   Examples: seismic inspections, below ground work
   Conditions to Take Effect
   Consequences of the Hazard - immediate / - escalating
   
Possible Event:
Leakages
Corrosion, Technical Defect; Erosion; External Impact; Errors at Production/Assembly; Operating Error; Errors in Process Controlling; Failure of Structure; Wear and Tear; Failure of Valves; Failure of Stuffing Boxes and Sleeve Gaskets; Illegal Operation Parameters; Insufficient Safety Measures
Release of Energy; Fire; Explosion; Radiation / Radiant Heat; Splinter with High Kinetic Energy; Local Damages; Failure of Equipment; Secondary Damage of Facilities through Escalation; Environmental Damage; Injuries (Toxic Impact, Smoke Poisoning); Fatalities (Suffocation, Heavy Burns)

Dust, Flue Gases and Fumes; Environmental Damage; Injuries (Toxic Impact); Fatalities (Suffocation, Toxic Impact)

Possible Event:
Leakages
Corrosion, Erosion; External Impact; Errors at Production/Assembly; Operating Error; Errors in Process Controlling; Failure of Structure; Wear and Tear; Failure of Valves; Failure of Stuffing Boxes and Sleeve Gaskets; Illegal Operation Parameters; Insufficient Safety Measures
Release of Energy; Fire; Explosion; Radiation / Radiant Heat; Splinter with High Kinetic Energy; Local Damages; Failure of Equipment; Secondary Damage of Facilities through Escalation; Environmental Damage; Injuries (Toxic Impact, Smoke Poisoning); Fatalities (Suffocation, Heavy Burns)

Dust, Flue Gases and Fumes; Environmental Damage; Injuries (Toxic Impact); Fatalities (Suffocation, Toxic Impact)

Possible Event:
Leakages
Corrosion, Erosion; External Impact; Errors at Production/Assembly; Operating Error; Errors in Process Controlling; Failure of Structure; Wear and Tear; Failure of Valves; Failure of Stuffing Boxes and Sleeve Gaskets; Illegal Operation Parameters; Insufficient Safety Measures
Release of Energy; Fire; Explosion; Radiation / Radiant Heat; Splinter with High Kinetic Energy; Local Damages; Failure of Equipment; Secondary Damage of Facilities through Escalation; Environmental Damage; Injuries (Toxic Impact, Smoke Poisoning); Fatalities (Suffocation, Heavy Burns)

Dust, Flue Gases and Fumes; Environmental Damage; Injuries (Toxic Impact); Fatalities (Suffocation, Toxic Impact)

Possible Event:
Leakages
Corrosion, Technical Defect; Erosion; Illegal Process Parameters; External Impact; Errors at Production/Assembly; Operating Error; Errors in Process Controlling; Wear and Tear; Loss of Isolation
Failure Misfunction; Release of Energy; Splinter with High Kinetic Energy; Local Damages; Dangerous Surface Temperatures; Injuries and Burnings; Fatalities
b. Equipment Specific Hazards

6. Dangerous Equipment

Possible Event:
Loss of functions
Operations without Instrument Covers; Technical Defect; External Impact; Errors at Production/Assembly; Operating Error; Errors in Process Controlling; Wear and Tear; Inappropriate Operations
Release of Energy; Splinters with High Kinetic Energy; Local Damages and Contaminations; Injuries; Fatalities

Consequences of the Hazard - immediate / - escalating

7. Ignition Sources

Possible Event:
Failure of Safety Systems (Protective Systems), Fire, Disregarding of Fire Breaks
Maintenance of E-Facilities; Welding; Use of Equipment that Sparks Light; Cutting and Severing; Failure of Cladding of Machines; Containers and Circuits of Inflammable Materials; Operating Errors; Use of Open Fire; Cleaning (Wiping) with Dry Cloths
Fire; Explosion; Splinters with High Kinetic Energy; Local Damage; Smoke; Injuries (Smoke Poisoning, Burns); Fatalities (Suffocation, Heavy Burns)

Consequences of the Hazard - immediate / - escalating

8. Lifting Facilities

Possible Event:
Falling Parts
Failure of Equipment; Overloading/Overwork; Operational Error
Local Damage; Failure of Cladding of Machines; Containers and Circuits; Failure of Structures; Injuries; Fatalities

Consequences of the Hazard - immediate / - escalating

9. Ionising Radiation

Possible Event:
Leakages/Releases
Inappropriate Handling; Operational Error; Controlling Error; Contaminated Product (due to an introduced radiation source); Equipment/Instruments with X-Rays; Errors at Production/Assembly; Errors at Using the PSA; Disregarding of Warnings
Toxic Impact; Environmental Damage; Injuries; Fatalities

Consequences of the Hazard - immediate / - escalating

10. General Radiation, not ionised

Possible Event:
External Impact
Fire; Sunlight; UV Light
Local Damage; Failure of Structure; Failure of Equipment; Failure of Cladding of Machines; Containers and Circuits; Fire; Injuries (Burns); Fatalities (Burns)

Consequences of the Hazard - immediate / - escalating
a. Substance Specific Hazards

11. Generation of Explosive Gases
Examples: Battery Run Facilities, Fermentation Gas from Cavities/Caverns
Possible Event:
Leakages
Technical Defects; External Impact; Operational Error; Errors in Process Controlling; Corrosion
Fire; Explosion; Splinters with High Kinetic Energy; Smoke; Injuries (Smoke Poisoning, Burns); Fatalities (Suffocation, Heavy Burns)
Consequences of the Hazard - immediate / - escalating

12. Utility Facilities
Possible Event:
Loss of Function
Technical Defects; Errors at Production/Assembly; Errors in Process Controlling; Operating Error
Leakages; Malfunctioning of Secondary/Supplied Facilities; Escalation Due to Secondary Events
Consequences of the Hazard - immediate / - escalating

13. Safety Systems
Examples: Blow Down Systems, Fire Extinguishing Systems, CO2 Extinguishing Systems
Possible Event:
Loss of Functions
Technical Defects; Errors at Production/Assembly; External Impact; Operating Error
Leakages; System Failures; Escalation due to Secondary Events
Consequences of the Hazard - immediate / - escalating

14. Instrumentation and Control Systems
Examples: Process Control Systems, Remote Control Systems, Process Data Register
Possible Event:
Loss of Control
Technical Defects; Errors at Production/Assembly; External Impact; Operating Error
Failure Malfunction; Local Damages; Failure of Cladding of Machines; Containers and Circuits Escalation Due to Secondary Events
Consequences of the Hazard - immediate / - escalating
c. General Hazards

15. Special Locations
Examples: Facilities on Critical Surfaces (Swamps, Water), Flood Areas, Offshore Platforms
Conditions to Take Effect
Consequences of the Hazard - immediate / - escalating

16. Transportation / Traffic
Example: Airborne, Roads, Railways, Waterways
Conditions to Take Effect
Consequences of the Hazard - immediate / - escalating

17. Surrounding-Related Hazards
Examples: Earthquake, Severe Weather (Windstorm, Precipitation), Dust
Conditions to Take Effect
Consequences of the Hazard - immediate / - escalating

18. General Safety
Examples: Drilling Facilities, Natural Gas Storage and Transportation Facilities
Conditions to Take Effect
Consequences of the Hazard - immediate / - escalating

Possible Event:
- Failure of Structure
- Corrosion; Technical Defect; Fatigue; Earthquake; Severe Weather; Scouring; Subsidence; Ice Floe; Ship Collision
- Local Damages; Collapse of the Platform; Failure of Cladding of Machines, Containers and Circuits; Injuries; Fatalities

Possible Event:
- Collision
- Damaged Equipment; External Impact/Events; Earthquakes; Severe Weather; Loss of Control/Operations; Operational Error
- Local Damage; Failure of Cladding of Machines, Containers and Circuits; Failure of Structures; Fire; Explosion; Environmental Damage; Injuries (to Third Persons) (Toxic or other Impact); Fatalities

Possible Event:
- General Facility Damages
- Design Error; Operational Error; Insufficient Alarming; Errors at Using the PSA; External Impact
- Impact on Personnel; Failure of Structure; Failure of Equipment; Failure of Cladding of Machines, Containers and Circuits; Loss of Protective Equipment; Escalation of Secondary Events; Injuries; Fatalities

Possible Event:
- Loss of Control
- Activities of Unauthorized Third Persons; Strikes; Military Operations/Practices
- Damage of Facilities; Injuries; Fatalities; Escalation due to Secondary Events
a. Natural Gas Cavern Storage

Date: 2007
Customer: German Subsidiary of European Natural Gas Producer and Supplier
Savings: Survey of the HSE status of the planned above ground facilities and safety enhancement by recommendation of additional mitigation measures

**Issue:**

During the FEED phase of the projected expansion of an existing gas cavern storage facility the operator intended to get a detailed overview of the HSE status achieved by the foreseen or existing technical and organisational safeguards.

**Methodology & Results:**

In the forefront of the review eight different facility units inclusive of their tie-ins into the existing facility were defined. Altogether 151 scenarios were analysed with respect to implications on personnel and asset safety as well as on the environment and the company’s reputation by applying the systematic HAZID methodology. This approach facilitated the identification of potential medium or higher risk scenarios that could occur during the operation of the facility and to identify possible additional safeguards to mitigate these risks.

**Savings:**

The result was the identification of eight scenarios that pose a medium risk, 108 lower risk scenarios and 35 scenarios that represented no risk. By recommendation of additional safeguards the risk levels of all medium risk scenarios could be decreased to the lower risk level and even lower risk scenarios could be reduced. By introducing the recommended additional safety measures the operator is enabled to reduce his operating risk significantly.
b. Maritime Oil Jetty in the River Danube

Date: 2008
Customer: European Operator of a Planned Maritime Port in the River Danube
Savings: Survey of the HSE status of the planned facilities and Safety enhancement by recommendation of additional mitigation measures

Issue:

During the FEED/Basic Design phase of the projected expansion of the existing port facilities the operator requested a detailed overview of HSE status achieved by the foreseen or existing technical and organisational safeguards. This was to identify the mutual interference between the existing oil jetty including its connected facilities and the planned dry cargo facilities respectively open storage area.

Methodology & Results:

Altogether 77 scenarios were analysed with respect to implications on personnel and asset safety as well as on the environment and the company’s reputation by applying the systematic HAZID methodology. This approach facilitated the identification of potential medium or higher risk scenarios that could occur during the operation of the facility and to identify possible additional safeguards to mitigate these risks.

Savings:

The result was the identification of 48 scenarios that pose a medium risk and 29 lower risk scenarios. The recommendation of additional safeguards allowed the reduction of the risk levels of all medium risk scenarios to a level that is considered as low as reasonably practicable. By introducing the recommended additional safety measures the operator is enabled to reduce his operating risk significantly.
Safety & Risk Management Services

- Safety Case and Compliance Consultancy
- **Hazard Identification Studies (HAZID)**
  - Hazard Operability Studies (HAZOP)
  - SIL Studies (Safety Integrity Level)
  - Consequence Evaluation (Fire, Release, Explosion, Dispersion), Including CFD
  - EER Analysis (Escape, Evacuation, Rescue) (GL-Aeneas)
  - Quantitative Risk Analysis (QRA)
  - Decision Support (Risk Based Layout Studies)
  - Performance Standards
  - Large Scale Hazards Testing (Spadeadam)
  - Incident Investigation

Germanischer Lloyd
Industrial Services GmbH

Oil and Gas
Steinhöft 9
20459 Hamburg, Germany
Phone +49 40 36149-7700
Fax +49 40 36149-1781
glis@gl-group.com
www.gl-group.com/glis