



## 200 Series: Leadership and Management

### **Risk Management Standard and Matrix**

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Global Environmental, Health and Safety  
Indorama Ventures

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## **1. Purpose**

This standard establishes Indorama Ventures requirements to provide sites with a consistent approach for qualitatively ranking levels of risk as they relate to prioritizing environmental, health, and safety (EHS) recommendation/actions and process safety activities (e.g., PHAs and Facility Siting studies). It also provides target frequencies for use with quantitative methods for risk assessment associated with process safety activities such as PHA and Facility Siting studies.

## **2. Scope**

This standard applies to all Indorama Ventures owned/operated sites. This standard does not apply to joint ventures (JVs) in which Indorama Ventures is a minority owner, nor to third-party warehouses and tollers, unless specifically requested by the related Segment EHS Leader.

This standard must be implemented by each site. Until implementation of this standard is complete, each site must at a minimum be in compliance with the local applicable regulations.

## **3. Responsibilities**

Following is an overview of key responsibilities for this standard. Additional responsibilities, as applicable, are included in Section 4, Requirements.

### **3.1. Corporate EHS**

- 3.1.1. Provide ongoing technical assistance related to this standard.
- 3.1.2. Periodically audit sites to determine compliance with this standard.
- 3.1.3. Review, update and communicate to all Indorama Ventures sites any updates or changes to this standard and associated documents and tools.
- 3.1.4. Periodically review this standard to ensure its continuing adequacy and suitability to Indorama Ventures' operations.
- 3.1.5. Ensure this standard is consistently implemented from site-to-site within Indorama Ventures.
- 3.1.6. Communicate, as applicable, any lessons learned as a result of best practices identified or any non-compliances associated with implementation of this standard.

### **3.2. Site Head or Designee**

- 3.2.1. Ensure implementation of and compliance with this standard including that it is adhered to and so all employees receive the proper training, resources, and communications.
- 3.2.2. Ensure that each assessment using this standard is undertaken by an appropriate team of people (with the necessary experience and understanding of the plant operation and maintenance) and a competent person who understands the methodology of this standard.
- 3.2.3. Assist with the implementation of the standard; in particular:
  - Be thoroughly familiar with the requirements of this standard, and any associated procedures and work practices.
  - Provide support, resources and training needed to carry out the requirements of this standard.
  - Ensure required records are maintained on file.
  - Ensure compliance with standard by employees and contractors (as applicable).

### 3.3. Segment EHS

- 3.3.1. Guarantee that any site or local standard or procedure related to the same topic follows the corporate requirements at minimum.
- 3.3.2. Support the sites on any technical point related to the standard, including implementation.
- 3.3.3. Periodically evaluate sites' level of compliance with this standard.

### 3.4. Program Owner

- 3.4.1. Be thoroughly familiar with the requirements of this standard and local regulatory requirements.
- 3.4.2. Develop and implement the requirements of this standard and any local/regional regulatory requirements.
- 3.4.3. Review and monitor for compliance with the requirements of this standard, at least every five (5) years and per local regulatory requirements.
- 3.4.4. Develop an action plan to correct any non-conformance with local regulatory or Indorama Ventures requirements.

### 3.5. Employees and Contractors

- 3.5.1. All personnel must understand and follow the requirements of the standard including:
  - Being aware of and trained on, as applicable, the legal, regulatory and other requirements.
  - Immediately reporting any situations that may cause or have a potential to cause a non-compliance.
  - Completing any assigned regulatory tasks or actions (e.g., training).

- 3.6. In addition to the roles and responsibilities detailed above, the site-specific policy must define and document the roles and responsibilities for all personnel who play a role in implementing the standard, for example, as applicable:

#### Site Leadership Team

- Human Resources (HR)
- Legal
- EHS Personnel
- Medical Staff (or third-party licensed healthcare provider)
- Other applicable functions, as staffed at individual site level

## 4. Requirements

This standard shall be utilized to risk rank scenarios and to prioritize actions developed from EHS and Process Safety related activities performed to comply with the relevant IVL EHS Standards.

- 4.1. Risk ranking assessments include but are not limited to the following:

- Hazard Studies (i.e., Process Hazard Analysis (PHA), Layer of Protection Analysis (LOPA), Independent Protection Layer (IPL) study, Numerical Hazard Analysis (NHA), Facility Siting study, Fire Risk Assessment (FRA), etc.).
- Other Hazard/Risk Identification Programs.

- Hazard Studies for significant modifications and new projects.
- 4.2. The risk ranking methodology to be used for qualitative assessments is described in Attachment B. The Risk Matrix that shall be used is shown as Figure 2 of Attachment B. The Severity Categories are defined in Table 1 of Attachment B. The Frequency Definitions are defined in Table 2 of Attachment B and the Target Frequencies required to be met for each level of Severity is shown in the Risk Matrix and described in Table 4 of Attachment D.
- 4.3. For semi-quantitative assessments, such as a Layers of Protection Analysis (LOPA), and for quantitative assessments, such as a Numerical Hazard Analysis (NHA), and any others requiring a numeric target, the target frequencies for each Severity Category shown in the Risk Matrix (Figure 2 of Attachment B) and listed in Table 4 of Attachment D shall be used.
- 4.4. Where a national or local regulation sets more stringent requirements than this standard, those requirements shall be met by any Indorama Ventures operation that is subject to them.
- 4.5. When evaluating risk using the consequence analysis tables, co-located industrial neighbors must be considered prepared and trained to properly respond to an accidental release. Under such circumstances, these parties are not considered part of the “community” and will be considered the equivalent of an onsite “contractor”.
- 4.6. For this approach to be considered, the site shall communicate the hazardous scenario(s) with the co-located industrial neighbors and confirm they have the means to be alerted to a potential incident, and the ability to take proper emergency actions. This communication and evaluation must be documented.
- 4.7. Utilize Table 3a to prioritize and set target due dates for recommendations/actions from the EHS and Process Safety related assessments. Table 3b is provided as guidance and is not mandatory.
- 4.8. Timing
- This standard shall be used whenever there is a need for a qualitative assessment or a quantitative assessment to rank an outcome related to EHS or process safety risk criteria.
- 4.9. Clarifications
- This standard is provided for the management of individual scenarios or actions and is not intended for use in managing the overall (aggregate) risk for a site.
  - For PHAs/Facility Siting studies, where the individual hazard event frequency falls in the EHS-2 (Medium Risk Range) Risk Level, it is recommended that additional risk reductions be implemented if the actions are achievable and practicable based on readily available technology and divisional standards and practices to lower the risk to the EHS-1 (Low Risk Range) Risk Level. The proposed risk reduction actions and decisions shall be documented in the study.

## **5. Training**

Training requirements must be defined by the site. At a minimum, all training must be documented with the training date, the names of employees trained, the names of the trainer(s), the content of the training (or reference to content) and other site-specific/business segment requirements, when applicable.

### **5.1. Initial**

Training on the requirements of this standard must be provided to Indorama Ventures personnel based on their relevant responsibilities. At a minimum, personnel and/or management with direct responsibilities for this standard must be initially trained prior to conducting activities required by the standard.

### **5.2. Refresher**

Refresher training shall be provided periodically according to the requirements of this standard, and any local legal requirements, at appropriate intervals (e.g., changes to regulatory requirements), or at least once every five (5) years.

## **6. Recordkeeping**

Records associated with the standard must be controlled and retained in accordance with regulatory or site business segment record retention requirements, whichever is more stringent.

## **7. References**

- 7.1. IVL EHS-105 Notification of EHS Incidents
- 7.2. IVL EHS-107 Management of Actions
- 7.3. IVL EHS-109 EHS Metrics and Reporting
- 7.4. IVL EHS-110 EHS Audit Program
- 7.5. IVL EHS-406 IPL/SIL Assessment Methodology

## **8. Terms and Definitions**

See IVL EHS Glossary

## **9. Revision History**

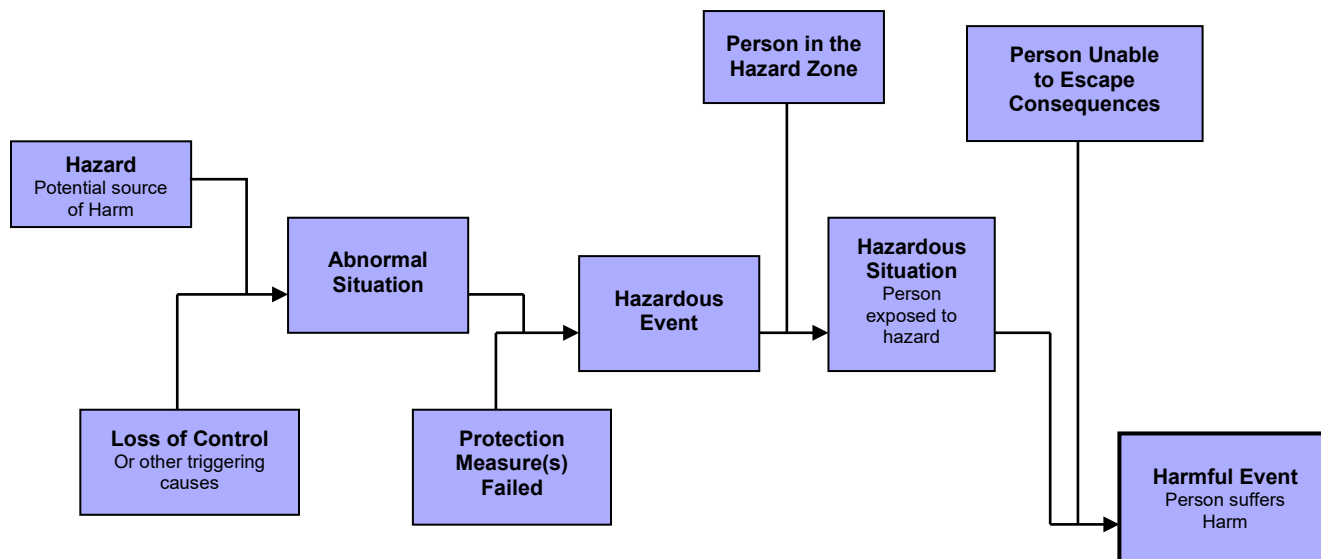
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Original	18 April 2022	Initial Release	Chad Wyble, Global Process Safety Program Director	Todd Hogue, VP, Global Head of EH&S	18 April 2025
1.0	09 August 2024	Updated implementation timeframe (Section 2) and Responsibilities (Section 3); made minor editorial updates.	Chad Wyble, Global Process Safety Program Director	Todd Hogue, VP, Global Head of EH&S	09 August 2029

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## Attachment A: Hazard Event Progression

Figure 1 shows the progression from hazard through loss of control to the occurrence of a harmful event. It uses harm to people but can equally apply to the outcome of harm to the environment, or damage to property.

**Figure 1. Harmful Event**



This figure shows how loss of control, or any other triggering failure(s), causes an abnormal situation and can place a demand on protective measures, such as trips, interlocks, relief valves, etc. A hazard event results when a demand occurs and the relevant IPL protective measures are insufficient, inadequately designed, or in a failed state, and do not function as intended. A hazard event in and of itself does not necessarily cause harm but should a person(s) be in the hazard zone, thus exposed to the hazard event, this results in a hazardous situation. If the person is unable to escape the harmful consequences of exposure, this is characterized as a harmful event due to the personnel injury.

## **Attachment B: Risk Matrix Methodology**

This Attachment provides details of the Risk Matrix Methodology that shall be used when performing EHS and Process Safety risk assessments. It also covers the requirements for prioritizing recommendations and action items resulting from these studies.

In many instances it will be appropriate to assess the level of risk both “as is” and again “after proposed action” to demonstrate that the action will be effective in providing the necessary risk reduction.

### **B.1. Introduction**

Before using this standard, those performing the risk assessment shall gather essential information and knowledge so that there is a clear understanding of the possible consequences (and the potential severity of the consequences) for the hazard event scenario of interest.

An understanding of the process operation is critical to determine the frequency for the scenario to occur. This includes, but is not limited to:

- a. an understanding of the equipment (including safety instrumented systems),
- b. the operating / maintenance procedures (operating conditions, operating procedures, maintenance / inspection programs, etc.),
- c. the staffing or occupancy levels,
- d. history of incidents at the site and within the industry, and
- e. emergency response protocols.

### **B.2. Hazard Event Scenario Consequence Evaluation**

Table 1 provides definitions of eight (A thru H) Severity Categories for the Hazard Event Scenario with “A” being the most severe consequence and “H” being the least severe consequence.

The assessment team performing the assessment should first identify the severity category of the hazard event scenario of interest, i.e. worst credible consequence scenario, using the eight-tier scale provided. While making the severity determination, no consideration shall be given to certain available safeguards that may be in place to prevent the scenario or minimize the impact under consideration. Safeguards will be considered during the assessment of frequency.

For example, when ranking the severity for a hazard event scenario involving a flammable vapor release that reaches a source of ignition and results in a flash fire, no consideration shall be given for the appropriate electrical area classification.

If a scenario involves both safety and environmental consequences, first list these consequences separately, then select both the highest safety outcome and the highest environmental outcome. For example: for a scenario in which the highest Environmental Consequence is identified to be Severity Category “F”, and for the same scenario, the On-site Injury and Illness highest Consequence is Severity Category “E”, carry both of these consequences forward for further evaluation.

For scenarios with consequences that are considered to be potentially extremely serious or potentially catastrophic (i.e., Severity Category A thru E), more analytical techniques should be considered. These may include techniques such as gas dispersion and explosion modelling, for example.

When evaluating health related or environmental consequences, the appropriate subject matter experts should be consulted.

#### **B.2.1 On-Site Injuries**

The On-site injury column in Table 1 covers concerns of potential personnel injuries and exposures. The eight-tier Severity Category scale ranges from a high of “A” which is a catastrophic category that is characterized as having a potential for multiple on-site fatalities, to



a low of "H", a minor category that is characterized as having potential for a single first-aid injury.

#### **B.2.2 Off-Site Injuries**

Considerations should be given to hazard event scenarios that have potential for toxic release (toxic and sensitizers) and also for fire, explosions or overpressures that could result in injuries as a result of property damage (broken windows, etc.).

The Off-Site Injury column provides definitions for potential events that may impact those outside of the facility boundaries. These range from a high of "A" which is a catastrophic Severity Category that is characterized by a potential for multiple off-site fatalities, to a low of "H" which is a minor Severity Category that is characterized by no impact to the community.

#### **B.2.3 Environmental and Other Effects**

Ground, air and/or water contamination concerns should be covered by identifying the possible consequence for the scenario under consideration and by review of the definitions provided in Table 1.

#### **B.2.4 Operability Definitions**

Operability issues identified during the consequence evaluation process are those issues that truly have no EHS consequence, such as when only business consequences can be identified.

For example, if a scenario identifies the potential for poisoning catalyst in a reactor bed that would lead to poor product quality and/or loss of productivity, and, if the scenario identifies that no EHS consequences can be determined from the scenario of concern, then the scenario can be classified as operability only. The business / facility may choose whether to apply this standard to consequence severity for operability only issues. However, clear documentation for the disqualification of the scenario as an EHS consequence severity should be prepared and maintained for future reference.

In cases in which the assessment of a scenario identifies both operability issues and EHS issues, consequence severity ranking for the EHS issues shall be completed and dealt with in accordance with this standard.

**Table 1. Consequence Definitions**

Severity Category	Credible Consequence of the Harmful Event		
	On-Site Injuries and Illnesses (One or More of the Consequences Below)	Off-Site Injuries and Illnesses (One or More of the Consequences Below)	Environmental and Other Effects (One or More of the Consequences Below)
A	Potential for: <ul style="list-style-type: none"> <li>• 100 or more fatalities</li> </ul>	Potential for: <ul style="list-style-type: none"> <li>• 50 or more fatalities</li> </ul>	Release of hazardous material with potential for: <ul style="list-style-type: none"> <li>• Off-site release with catastrophic off-site damage and long term clean-up (restored in 1 to 5 years)</li> </ul> Other Potential Impacts: <ul style="list-style-type: none"> <li>• More severe release than the level below</li> </ul>
B	Potential for: <ul style="list-style-type: none"> <li>• 50 to 99 fatalities</li> </ul>	Potential for: <ul style="list-style-type: none"> <li>• 10 to 49 fatalities</li> </ul>	Release of hazardous material with potential for: <ul style="list-style-type: none"> <li>• Off-site release with significant clean-up (restored in 1 year)</li> </ul> Other Potential Impacts: <ul style="list-style-type: none"> <li>• More severe release than the level below</li> <li>• Catastrophic contamination of water/land</li> <li>• Catastrophic loss of wildlife and wildlife habitat</li> <li>• Extensive community evacuation</li> <li>• Threat of loss of license to operate</li> </ul>
C	Potential for: <ul style="list-style-type: none"> <li>• 10 to 49 fatalities</li> </ul>	Potential for: <ul style="list-style-type: none"> <li>• 3 to 9 fatalities</li> </ul>	Release of hazardous material with potential for: <ul style="list-style-type: none"> <li>• Off-site release with extensive clean-up (restored in months)</li> </ul> Other Potential Impacts: <ul style="list-style-type: none"> <li>• More severe release than the level below</li> <li>• Severe damage to rivers/sea, flora/fauna or land resulting in recovery time (months)</li> <li>• Severe loss of wildlife and wildlife habitat</li> <li>• Public outrage</li> <li>• Government intervention</li> </ul>
D	Potential for: <ul style="list-style-type: none"> <li>• 3 to 9 fatalities</li> </ul>	Potential for: <ul style="list-style-type: none"> <li>• 1 to 2 Fatalities</li> <li>• Multiple permanent partial disability injuries</li> </ul>	Release of hazardous material with potential for: <ul style="list-style-type: none"> <li>• Off-site release with prolonged clean-up (restored in weeks)</li> </ul> Other Potential Impacts: <ul style="list-style-type: none"> <li>• Major contamination of water/land</li> <li>• Temporary damage to rivers/sea, flora/fauna or land resulting in recovery time (weeks)</li> <li>• Major loss of wildlife and wildlife habitat</li> <li>• Harmful effect on source of drinking water</li> <li>• Community evacuation</li> <li>• Catastrophic impact to property or assets</li> <li>• Damage to relationships with key stakeholders</li> </ul>

**Table 1. Consequence Definitions**

Severity Category	Credible Consequence of the Harmful Event		
	On-Site Injuries and Illnesses (One or More of the Consequences Below)	Off-Site Injuries and Illnesses (One or More of the Consequences Below)	Environmental and Other Effects (One or More of the Consequences Below)
E	Potential for: <ul style="list-style-type: none"> <li>• 1 to 2 Fatalities</li> <li>• Multiple permanent partial disability injuries</li> </ul>	Potential for: <ul style="list-style-type: none"> <li>• Permanent partial disability injury</li> <li>• Multiple hospitalizations (overnight stay)</li> </ul>	Release of hazardous material with potential for: <ul style="list-style-type: none"> <li>• Off-site release with quick clean-up (restored in days)</li> </ul> Other Potential Impacts: <ul style="list-style-type: none"> <li>• Short term damage to rivers/sea, flora/fauna or land resulting in short recovery time (days)</li> <li>• Minor loss of wildlife and wildlife habitat</li> <li>• Contamination of water/land</li> <li>• Plant Evacuation</li> <li>• Community Shelter-in-Place</li> <li>• Severe impact to site property or assets</li> </ul>
F	Potential for: <ul style="list-style-type: none"> <li>• Permanent partial disability injury</li> <li>• Multiple recordable injuries</li> </ul>	Potential for: <ul style="list-style-type: none"> <li>• Single hospitalization (overnight stay)</li> <li>• Multiple first aid injuries</li> </ul>	Release of hazardous material with potential for: <ul style="list-style-type: none"> <li>• On-site release beyond secondary containment and requiring clean-up and possible response by the site ERT</li> </ul> Other Potential Impacts: <ul style="list-style-type: none"> <li>• Plant Shelter-in-Place</li> <li>• Moderate impact to site property or assets</li> <li>• Regulatory compliance issue which leads to a regulatory consequence, such as a Notice of Violation or Compliance Order</li> <li>• Limited Community Impact</li> </ul>
G	Potential for: <ul style="list-style-type: none"> <li>• Recordable injury</li> <li>• Multiple first-aid injuries</li> </ul>	Potential for: <ul style="list-style-type: none"> <li>• First-aid / Minor injury</li> </ul>	Release of hazardous material with potential for: <ul style="list-style-type: none"> <li>• On-site release within existing secondary containment possibly including small ERT response.</li> </ul> Other Potential Impacts: <ul style="list-style-type: none"> <li>• Permit deviation</li> <li>• Exceedance of permit/emission limits that does not lead to a regulatory consequence</li> <li>• Minor impact to the community with isolated complaints.</li> <li>• Minor impact to site property or assets</li> </ul>
H	Potential for: <ul style="list-style-type: none"> <li>• First-aid / Minor injury</li> </ul>	No impact	Release of hazardous material with potential for: <ul style="list-style-type: none"> <li>• Minor on-site release requiring no follow-up and no ERT response.</li> </ul> Other Potential Impacts: <ul style="list-style-type: none"> <li>• Minor release below permit/emission limits</li> <li>• Minor impact to site property or assets</li> </ul>

### B.3. Harmful Event Frequency Definitions

Table 2 provides definitions for the Harmful Event Frequency for the hazard event scenario under consideration. When determining the event frequency category, the assessment team shall take into consideration those safeguards which are available and in place to reduce the frequency of the Harmful Event occurring.

**Table 2. Frequency Definitions**

<b>Frequency Category</b>	<b>Scenario Harmful Event Defined Frequency Range</b>	<b>Description</b>
1	$>10^{-7}$ /yr to $10^{-6}$ /yr	
2	$>10^{-6}$ /yr to $10^{-5}$ /yr	Scenario very unlikely to happen within the life of this asset.
3	$>10^{-5}$ /yr to $10^{-4}$ /yr	
4	$>10^{-4}$ /yr to $10^{-3}$ /yr	Scenario unlikely to happen within the life of this asset.
5	$>10^{-3}$ /yr to $10^{-2}$ /yr	Scenario may happen within the life of this asset. It may have happened in the life of directly similar facilities internal or external to the company.
6	$>10^{-2}$ /yr to $10^{-1}$ /yr	Scenario likely to happen within the life of this asset. Current personnel may have knowledge, but no experience of its occurrence.
7	$>10^{-1}$ /yr to 1 /yr	Scenario has a high likelihood of happening in a year. For an operating plant, the event has probably happened in the last five years.
8	$>1$ /yr	Scenario can happen several times per year

It is difficult for an assessment team to categorize the likely frequency unless there is direct experience of it: that is to say, when it falls within Frequency Category “8” or “7”. Any hazard event scenario with a Harmful Event Frequency lower than Frequency Category “8” or “7”, falls outside the range of direct experience and requires the team to further analyze the trigger events and relevant effective safeguards of the scenario. Refer to Table C-4 of the IVL EHS-406 IPL Assessment Methodology standard for a listing of Typical Initiating Cause Frequencies and Tables C-5 thru C-9 for Risk Reduction Factors.

In order to make a reasoned assessment of the potential Harmful Event Frequency, it is necessary to consider the model shown in Figure 1 of Attachment A. The assessment team needs to identify the causes of loss of control, or other triggering failure cause(s) and assign a frequency to that triggering failure. Each of the risk reduction preventive measures (safeguards) needs to be identified and, in relation to safety of people, the probability of a person being present in the hazard zone needs to be assessed together with the probability of whether, when actually present, there is a reasonable possibility of escape before suffering harm.

In the absence of performing a numerical hazard analysis, the probability of either 0.1 or 1 should be used for a person being present; using 0.1 only if the area is unoccupied 90% or more of the time and using 1.0 for all other circumstances. Also, conservatively use a probability of 1 for a person being unable to escape before suffering harm.

Whenever sufficient data is available, a quantitative assessment of risk should be performed rather than a qualitative assessment.

Further guidance on establishing the frequency of the harmful event is given in the IVL EHS-406 IPL/SIL Assessment Methodology standard.

#### B.4. Risk Ranking and Required Action

The purpose of defining the risk is to establish whether the safeguards in place are adequate, and if not, that appropriate actions are taken to reduce the risk to an acceptable level.

Using the instructions above, the assessment team shall evaluate the scenario using Tables 1 and 2 to establish the Severity and Frequency, respectively. Then, using Figure 2, the Severity and Frequency rankings shall be located on the Risk Matrix. The intersection of these rankings shall be defined as the "risk". Each risk shall be located within a range that defines the appropriate action to be taken to reduce the risk to an acceptable level. Guidance relating to the appropriate level of action based on the risk level is given in Table 3a.

The initial risk of each hazard event scenario and the reduced risk following implementation of appropriate action(s) shall be documented.

**Figure 2. Risk Matrix**

	Frequency Category							
	>10 <sup>-7</sup> to 10 <sup>-6</sup> /yr	>10 <sup>-6</sup> to 10 <sup>-5</sup> /yr	>10 <sup>-5</sup> to 10 <sup>-4</sup> /yr	>10 <sup>-4</sup> to 10 <sup>-3</sup> /yr	>10 <sup>-3</sup> to 10 <sup>-2</sup> /yr	>10 <sup>-2</sup> to 10 <sup>-1</sup> /yr	>10 <sup>-1</sup> to 1/yr	>1/yr
Severity Category	1	2	3	4	5	6	7	8
A	EHS-2	EHS-3	EHS-3	EHS-3	EHS-3	EHS-4	EHS-4	EHS-4
B	EHS-2	EHS-3	EHS-3	EHS-3	EHS-3	EHS-4	EHS-4	EHS-4
C	EHS-2	EHS-2	EHS-3	EHS-3	EHS-3	EHS-4	EHS-4	EHS-4
D	EHS-1	EHS-2	EHS-3	EHS-3	EHS-3	EHS-4	EHS-4	EHS-4
E	EHS-1	EHS-2	EHS-2	EHS-3	EHS-3	EHS-3	EHS-4	EHS-4
F	EHS-1	EHS-1	EHS-2	EHS-2	EHS-3	EHS-3	EHS-3	EHS-4
G	EHS-1	EHS-1	EHS-1	EHS-2	EHS-2	EHS-2	EHS-3	EHS-3
H	EHS-1	EHS-1	EHS-1	EHS-1	EHS-1	EHS-2	EHS-2	EHS-3

EHS-4 Very High Risk Range (Unacceptable Region – Immediate risk reduction required)

EHS-3 High Risk Range (Intolerable Region – Schedule risk reductions for implementation)

EHS-2 Medium Risk Range (Tolerable Region – Acceptable if further risk reduction is impracticable)

EHS-1 Low Risk Range (Broadly Acceptable Region – No further risk reduction necessary)

See Attachment D for additional information on the Target Frequency for each Severity Category

**Table 3a. Risk Level Action Required**

Risk Level	Action Required	
	Existing Operating Plant	Design Proposals for New Plants or Modifications to Existing
EHS – 4 Very High-Risk Range	<p>Scenarios in this risk level are those that have been identified as having potentially high severity consequences with a high likelihood of occurrence. Continued operation at this level of risk is unacceptable. Under these circumstances, these findings shall be reported to the Site Head and it is essential that immediate measures be taken to mitigate this risk to the EHS-3 risk level or discontinue operations (or activity) until the hazard can be addressed.</p> <ul style="list-style-type: none"> <li>○ EHS-4 recommendations requiring project funding shall be considered Safety Mandatory projects.</li> </ul>	<p>The proposals need radical change. Implement a change to chemistry proposed and/or apply principles of inherent safety to the design.</p> <p>Keeping the original design and simply adding more protective measures is not an acceptable solution.</p>
EHS – 3 High Risk Range	<p>Scenarios that are ranked in this risk level are considered unacceptable. For operating plants, risk reduction measures, to achieve at least EHS 2, shall be identified and assigned completion dates and tracked per IVL EHS-107. These measures shall be implemented in a timely manner following the targets below:</p> <ul style="list-style-type: none"> <li>• Within a timely manner not to exceed 9 months for implementation of administrative / procedural controls.</li> <li>• Within a timely manner not to exceed 66 months for implementation of major expense or capital project expenditures. <ul style="list-style-type: none"> <li>○ EHS-3 recommendations requiring project funding shall be considered Safety Mandatory projects.</li> </ul> </li> </ul> <p>Whenever further studies are required to develop the basis for recommendations, studies should be completed, and resolution identified in a timely manner not to exceed 12 months</p> <p>Extensions of all recommendations within the maximum targets above may be extended per the Site's established Delegation of Authority (DOA) process.</p> <p>Extensions beyond the maximum targets for recommendations associated with G and H scenarios may be extended per the Site's established Delegation of Authority (DOA) process.</p> <p>Extensions beyond the maximum targets for recommendations associated with Severity A thru F scenarios, must have a prioritized plan established and be approved through the IVL EHS-114 Corporate Variance process.</p>	<p>If possible, there should be a change in the design to introduce inherent safety.</p> <p>If changes are not feasible then further risk reduction measures shall be introduced to reduce the risk level to at least EHS – 2.</p>

**Table 3a. Risk Level Action Required**

Risk Level	Action Required	
	Existing Operating Plant	Design Proposals for New Plants or Modifications to Existing
EHS – 2 Medium Risk Range	<p>For scenarios assessed at this tolerable risk level, existing operating plants shall determine whether further risk reduction is practicable. Implementing further risk reduction measures for these scenarios will be done at the discretion of the Site Head or delegate.</p> <p>In regulatory regimes where ALARP demonstration is required, such demonstration shall be documented.</p> <ul style="list-style-type: none"> <li>○ EHS-2 recommendations requiring project funding shall be considered Safety Discretionary projects.</li> </ul> <p>The facility should continue to use current good practice to ensure that process related risk does not exceed this range.</p>	<p>Ensure that current good practice has been used and justify why there are not any other measures that should be implemented to reduce the risk further.</p> <p>Any such measures identified should be included in the design, at the discretion of the Project Manager, and put in place to maintain or lower the level of risk.</p>
EHS – 1 Low Risk Range	<p>This level of risk is broadly acceptable as indicative of a well-managed operation. Ensure that current good practice has been used and that there are steps in place to maintain the level of risk at this level.</p> <ul style="list-style-type: none"> <li>○ EHS-1 recommendations requiring project funding shall be considered Safety Discretionary projects.</li> </ul>	<p>Ensure that current good practice has been used and that there will be steps in place to maintain the level of risk at this level.</p>

**Table 3b. Risk Level Reviews and Endorsements Guidance (see Attachment C for further guidance)**

<b>Risk Level</b>	<b>Risk Review Guidelines</b>	<b>Applicable Severity Levels: Frequency</b>
EHS – 4 Very High-Risk Range	<p>Risk Reviews for A thru H Severity scenarios operating in the EHS-4 risk range are only necessary at the time the EHS-4 risk range is determined and immediately mitigated to reach the EHS-3 or lower risk range.</p> <p>No follow-up Risk Reviews are recommended since there is an expectation of no EHS-4 scenarios previously discovered to be currently in operation.</p>	Not Applicable
EHS – 3 High Risk Range	<p>Risk Reviews for A thru F Severity scenarios operating in the EHS-3 risk range are recommended to be conducted Annually.</p> <p>Risk Reviews for G thru H Severity scenarios operating in the EHS-3 risk range are recommended to be conducted at least once prior to or during the next PHA Revalidation.</p>	<p>A thru F: Recommended Annually</p> <p>G thru H: Recommended per Revalidation Process and Schedule</p>
EHS – 2 Medium Risk Range	Risk Reviews for A thru H Severity scenarios operating in the EHS-2 risk range are recommended to be conducted at least once prior to or during the next PHA Revalidation.	A thru H: Recommended per Revalidation Process and Schedule
EHS – 1 Low Risk Range	Risk Reviews for D thru H Severity scenarios operating in the EHS-1 risk range are recommended to be conducted at least once prior to or during the next PHA Revalidation.	D thru H: Recommended per Revalidation Process and Schedule



## **Attachment C: Risk Review and Endorsement Guidance**

The Risk Review and Endorsement process is recommended as a best practice but is not mandatory. It is intended to confirm that the site risks of an existing operating system associated with the Risk Levels identified in Table 3b have been properly reviewed and endorsed for continued operation. This recommended guidance applies only to PSM covered sites and non-PSM covered sites with HHPS (e.g., related to PHA or Facility Siting studies).

### **Risk Review process:**

- Review the installed safeguards and mitigation systems, which includes physical equipment and human responses, to ensure they are effective, operating per any original design assumptions, are in good health, and performance monitoring of the safeguards are in place.
- Review incident reports and operational performance records for any history of successful or failed activations of safeguards and mitigation systems that have occurred between reviews.
- Review inspection and maintenance records.
- Verify that the risk reduction action plans have been developed, prioritized, and communicated. In addition, verify target dates for existing open actions are current and on track for completion and verify that closed actions are effective. Ensure all target dates for open actions are in accordance with the requirements of Table 3a.
- Verify that any critical training that is associated with a credited safeguard is current (i.e., operator response to critical alarms, and emergency response training).

### **Endorsement process:**

- All existing risk scenarios with a severity of A thru F operating in the EHS-3 risk range at the time of the review are to be endorsed for continued operation by the Site Head or delegate with notification to the CTO/Manufacturing Head.
- All other risk reviews conducted as part of the PHA Revalidation process are to be endorsed for continued operation by the Site Head or delegate with the authority of approving the PHA.
- Any findings discovered during the reviews that indicate the site is out of compliance with this standard, such as having risk reduction action due dates that are beyond the maximum timing allowed in Table 3a, or a determination that there are no further risk reduction measures practicable to lower the risk below the EHS-3 risk range, shall be documented and submitted for approval per the requirements of the IVL EHS-114 EHS Standard Variance Request process.

### **Timing:**

- The timing for the recommended reviews is shown in Table 3b above.
- The Site Head or delegate may increase the frequency of reviews as desired. The increase in frequency should be considered if repeat activations or repeat failures have occurred.

## **Attachment D: Target Frequencies for Quantitative Assessments**

There are a number of methodologies that require some form of target frequency for assessment of appropriate levels of risk reduction. These include but are not limited to: Fault Tree Analysis (FTA), Layer of Protection Analysis (LOPA), Event Tree Analysis (ETA), and other forms of Numerical Hazard Analysis (NHA).

The risk matrix in Figure 2 of Attachment B, and more specifically the target frequency designations and required actions, have been established for use in assessing single event consequence scenarios. Severity categories reflect levels of risk to any person within the hazard zone.

When using Table 4 shown below, the analysis shall include an assessment of all of the loss of control or other triggering causes that are considered to lead to the scenario harmful event, together with the relevant risk reduction layers for each triggering cause<sup>1</sup>.

The target frequency designations in Table 4 reflect Indorama's criteria to which new processes / units and modifications to existing processes shall be designed. It is also the numerical criteria for quantitative risk assessments for existing processes/units.

If the frequency of a single event consequence scenario is found to lay on the boundary of the EHS-3 (High Risk Range) and EHS-2 (Medium Risk Range) Risk Levels, it is considered to be in the EHS-2 Risk Level. Similarly, if the frequency of a single event consequence scenario is found to lay on the boundary of the EHS-1 (Low Risk Range) and EHS-2 (Medium Risk Range) Risk Levels, it is considered to be in the EHS-1 Risk Level.

However, if the frequency of a single event consequence scenario is found to lie on the boundary of the EHS-4 (Very High-Risk Range) and EHS-3 (High Risk Range) Risk Levels, it is considered to be in the EHS-4 Risk Level.

For revalidations of existing processes/units where existing Independent Protection Layers (IPLs) exceed the target frequency criteria (i.e. existing IPLs achieve a target event frequency lower than target frequency criteria), these IPLs shall be maintained at that level.

Table 4 does not imply that the level of risk achieved by meeting the target frequency is "As Low As Reasonably Practicable" (ALARP). Demonstration of ALARP should be done on a case-by-case basis. It will also depend on the regulatory regime and what risk measure is used within that regime for guidance on tolerability. In some instances, the measure used will be individual risk (for the person most at risk from the scenario in question). This will influence the approach to ALARP demonstration. Societal risk is also a factor that is to be included in such demonstrations.

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<sup>1</sup> For example, a runaway reaction in a reactor may be triggered by (a) failure of the temperature control loop, (b) cooling water pump tripping, and (c) spurious closure of trip valve in cooling water line. All of these would be included in the analysis.

**Table 4. Target Frequency Table**

Severity Category	Tolerable Target Frequency (per year)	Broadly Acceptable Target Frequency (per year)
	EHS-3 / EHS-2 Boarder	EHS-2 / EHS-1 Boarder
A	$1 \times 10^{-6}$	$>1 \times 10^{-7}$
B	$1 \times 10^{-6}$	$>1 \times 10^{-7}$
C	$1 \times 10^{-5}$	$1 \times 10^{-7}$
D	$1 \times 10^{-5}$	$1 \times 10^{-6}$
E	$1 \times 10^{-4}$	$1 \times 10^{-6}$
F	$1 \times 10^{-3}$	$1 \times 10^{-5}$
G	$1 \times 10^{-1}$	$1 \times 10^{-4}$
H	1	$1 \times 10^{-2}$