

# Classification of Process Safety Incidents and Near Misses

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Process Safety

# Overview

- Incident Management – Background
- Classification of Process Safety Incidents and Near Misses - Overview
- Incident Classification Based on Actual Outcome (PSI)
  - ▶ Incident Levels
  - ▶ Material Factors
- Incident Classification Based on Potential Outcome (PSI, sPSI, PSNM)
  - ▶ Risk Matrix for Incident Management Purposes
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  - ▶ Examples

# Incident Management – Background

## In the Past

- Incident management was based only on the **actual outcome** of the incident



Process Safety



Occupational Safety

## Nowadays

- Incident management was supplemented by a risk-based approach to answer the question:
  - ▶ Could **something worse** have happened?
- **Potential outcome** has to be rated for both
  - ▶ Incidents and
  - ▶ Near Misses

# New Incident Management

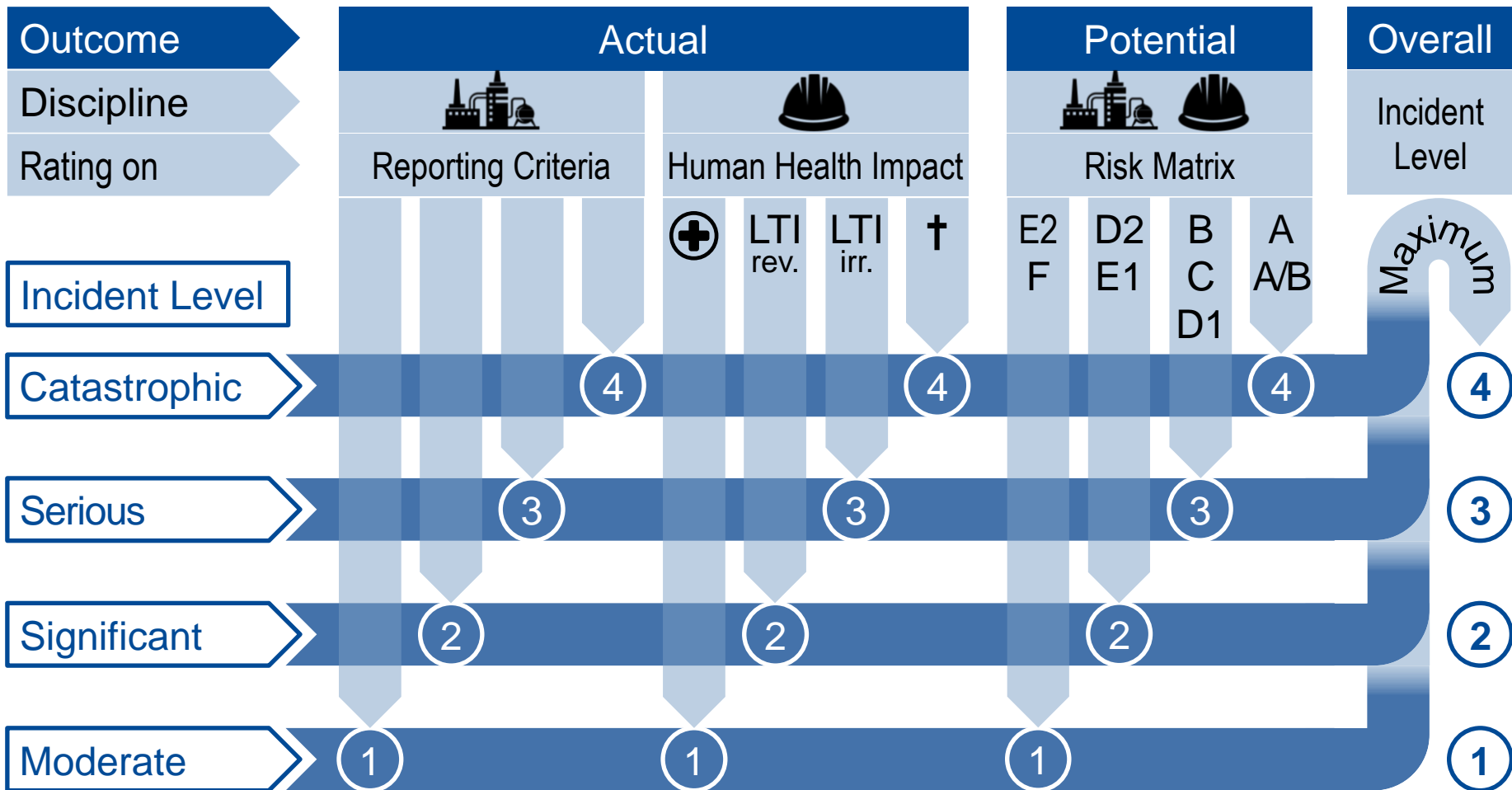
## Purpose

- Identify risks with **potentially high impact**
- **Focus** on investigation and mitigation of high risks

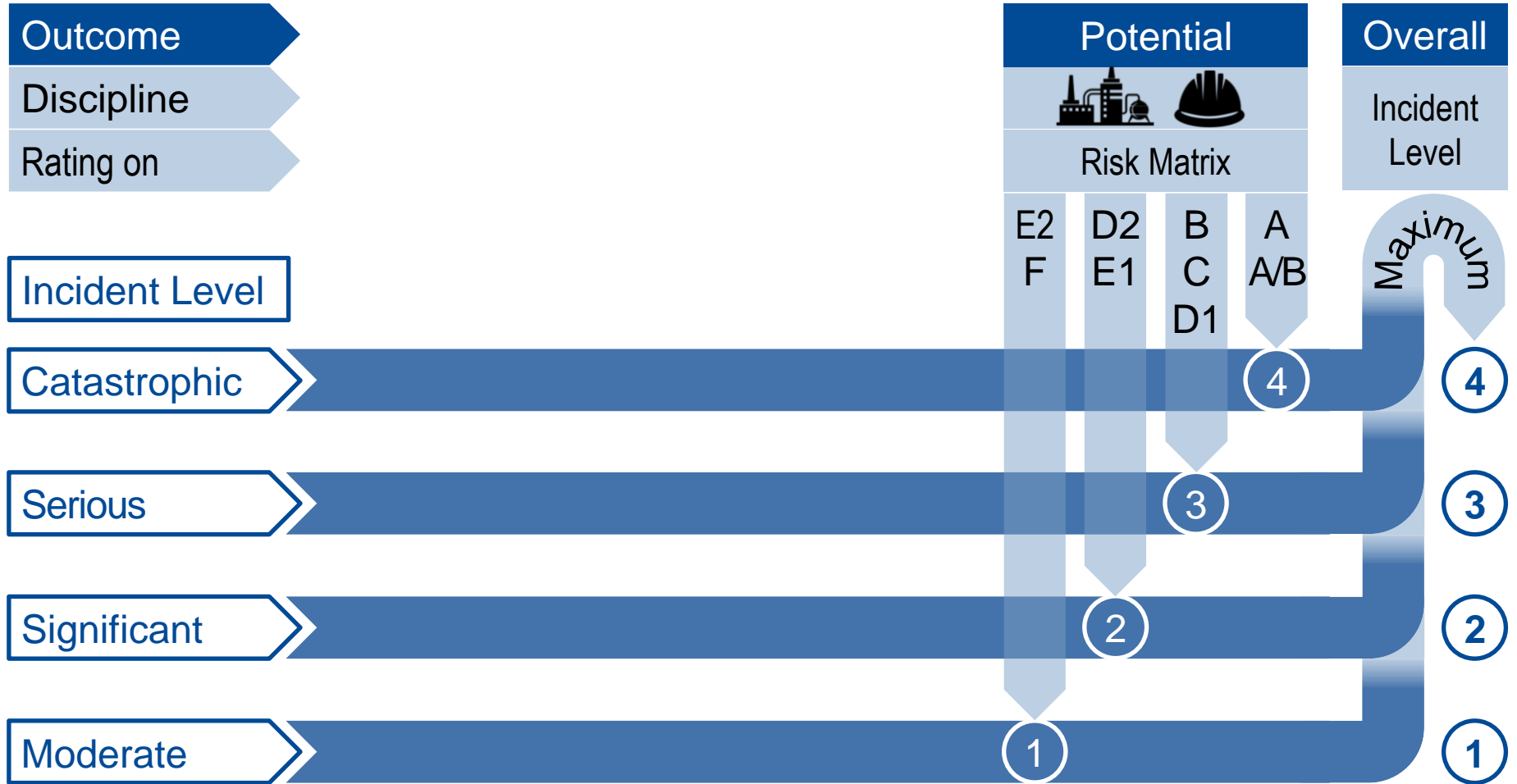
## Method

- All **incidents** and **near misses** have to be reported in a database
- All incidents and near misses have to be classified, based upon **actual** and **potential outcome**
- Determine the **incident level** based on the **actual outcome** by using **reporting criteria**
- Also determine the **incident level** based on the **potential outcome** by using the **risk matrix**
- The **overall incident classification** is the highest of either actual outcome or potential outcome

# Incident Classification - Overview



# Classification of Near Misses - Overview



# Classification of Actual Outcome (1/3)

## Criteria and Procedure

Classification of actual outcome of Process Safety Incidents (PSI) according ICCA<sup>1</sup> reporting criteria

- Human Health Impact
- Direct Damage Costs as a Result of Fire, Explosion or Implosion
- Chemical Impact Beyond Secondary Containment
- Community Impact (Shelter-in-Place, Evacuation)
- Environmental Impact (off-site)

<sup>1</sup> ICCA ≡ International Council of Chemical Associations

# Classification of Actual Outcome (2/3)

## Incident Levels (IL)

IL	Human Health Impact	Direct Damage Costs <sup>1</sup>	Community Impact <sup>2</sup>	Chemical Impact Beyond Secondary Containment <sup>3</sup>
①	1 LTI, Reversible Injuries	≥ 2.500 € < 250.000 €	≤ 3 Std. Shelter-in-Place	≥ TQ confined and beyond SC < 5 × TQ × MF beyond SC
②	≥ 2 LTI, Reversible Injuries	≥ 250.000 € < 2.500.000 €	> 3 Std. Shelter-in-Place	≥ 5 × TQ × MF beyond SC < 25 × TQ × MF beyond SC
③	≥ 1 LTI, Irreversible Bodily Damage	≥ 2.500.000 € < 25.000.000 €	≤ 1 Day Evacuation	≥ 25 × TQ × MF beyond SC
④	≥ 1 Fatalities	≥ 25.000.000 €	> 1 Day Evacuation	NA

<sup>1</sup> Due to Fire, Explosion or Implosion

<sup>2</sup> Officially declared (including precautionary)

<sup>3</sup> Diked area, chamber etc.

**TQ** = Threshold Quantity

**MF** = Material Factor

**SC** = Secondary Containment



# Classification of Actual Outcome (3/3)

## Material Factors (MF)

Material Hazards Hazard Statements	PSI-TQ Menge	Material Factor Criteria		MF	Examples
		bp	Relevant Hazard Statements		
Fatal H300, H310, H330	≥ 1 kg	< 60°C + Gases		0,5	HCN, Cl <sub>2</sub> , POCl <sub>2</sub>
		≥ 60°C		1	TDI
Toxic / Harmful H301, H311, H331 / H302, H312, H332	≥ 10 kg	< 60°C	H331, H332	0,5	NH <sub>3</sub> , HCl
		≥ 60°C	H301, H311, H331, H312, H332	1	2-Ethylhexanol
			H302	2	DEG
Hazardous Substances without Acute Toxicity all Hazard Statements <b>except</b> H300, H310, H330/H301, H311, H331/H302, H312, H332 as well as EUH Statements	≥ 100 kg		H220, H221, H224	0,5	H <sub>2</sub> , HC≡CH
			All GHS classified substances <b>except mentioned here</b>	1	EtOH, White Spirit
		≥ 60°C	H226	2	3-Hexanol
			H341, H361, H362, H373	2	

# Potential Outcome of Incidents and Near Misses

## Criteria

Rating of potential outcome is **mandatory** for

Category	Ereignistyp
Incident	<b>PSI</b> Process Safety Incident
Near Miss	<b>sPSI</b> small Process Safety Incident ( $\geq 10\%$ of ICCA Values)
	<b>PSNM</b> Process Safety Near Miss
	<b>AFPD</b> Activation or Failure of a Protective Device

## Procedure

Evaluation is preferably carried out with **risk matrix for incident management purposes**, resulting in a risk class A...F which corresponds to an incident Level ① ... ④<sup>1</sup>.

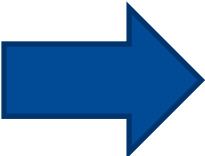
Remark: not the raw risk but the risk with installed countermeasures is to be considered!

<sup>1</sup> Except AFPD

# Rating of Potential Outcome by Risk Matrix for Incident Management Purposes

## Risk Matrix

		Severity S			
		S1	S2	S3	S4
Probability P	P0	A	B	D1	E1
	P1	A/B	B	E1	E2
	P2	B	C	E2	F
	P3	C	D2	F	F
	P4	E2	F	F	F



## Assignment of Risk Classes A ... F to Incident Levels ① ... ④

Risk Class	Incident Level
A, A/B	④ Catastrophic
B, C, D1	③ Serious
D2, E1	② Significant
E2      F	① Moderate

Think in terms of orders of magnitude!



In cases of non-applicability of the risk matrix a case-by-case decision is necessary!

# Rating of Potential Outcome by Risk Matrix

## Definition of Probability P and Severity S

Probability P		Criteria
<b>P0</b>	Frequent	It is anticipated that harm/scenario will happen (once per year)
<b>P1</b>	Occasional	Harm/scenario may happen occasionally (approximately once in 10 years)
<b>P2</b>	Rare	Harm/scenario may happen rarely or almost happened within a plant lifetime (approximately once in 100 years)
<b>P3</b>	Very rare	Harm/scenario is not anticipated, but thinkable under very unfavorable circumstances (approximately once in 1000 years)
<b>P4</b>	Reasonably not to be expected	Not a credible scenario, reasonably not to be expected (approximately less than once per 10000 years)

Severity S	
<b>S1</b>	Potential for one or more fatalities
<b>S2</b>	Potential for one or more serious injuries <sup>1</sup>
<b>S3</b>	Potential for one or more LTI/RDI. Reasonably a persistent disability is not assumed
<b>S4</b>	Potential for minor injuries, or irritation (First Aid Case - FAC)

<sup>1</sup> Severe head injury, amputation, burns affecting > 10% of body surface, loss of eye or sight etc.

# Applicability of Risk Matrix

## Applicable in

- Well defined scenarios

## Not applicable in

- Undefined common causes  
e.g. design failures, wrong material of construction, poor maintenance, insufficiently qualified operators, staff shortages

## General rules

- Consider only reasonable impacts
- Let common sense prevail

# Rating of Potential Outcome – Example 1

## Incident

- Emission of 900 kg gaseous Hydrogen Chloride (H280, H314, H331) over a period of 9 hours to the atmosphere, i.e. 100 kg/h

**Actual Outcome:** Incident Level ② Significant

## Potential Outcome:

Boundary conditions must be defined:

Outlet (height, personnel presence)?

H331 = toxic if inhaled → max. S1, probably S2

} Conceivable Escalation Potentials

If Leakage...

... due to operating error → P2, therefore P2×S2 risk class C and → incident level ③ serious

... due to wrong gasket → design failure, matrix not applicable

... due to assembly error → „human failure“ → P2/P3 × S2 → C ③ / D2 ②

# Rating of Potential Outcome – Example 2

## Incident

- Emission of 5000 kg of an extremely flammable gas (H220)
- The gas cloud was diluted by strong wind and blown over sparsely populated area
- No ignition
- No injuries or fatalities

**Actual Outcome:** incident level ③ serious

## Potential Outcome:

If the wind had blown the extremely flammable gas cloud into residential areas and had ignited, there would be an escalation potential for one or more fatalities

→ incident level ④ catastrophic

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# Potential Outcome due to Activation or Failure of a Protective Device (AFPD)

- By definition, only a **process-related activation of a protective device** fulfills the criterion of an AFPD
- A design-compliant activation is assigned the incident level ① moderate
- The **failure of a protective device** is generally - i.e. regardless of the triggering moment – assigned the incident level ③ serious (not mitigated raw risk of risk class B or C)