



ANSI / API RP-754

Process Safety Performance Indicators for the Refining & Petrochemical Industries

Part 2: Tier 1 and 2 Process Safety Events

Kelly Keim
Vice - Chair API RP-754 Drafting Committee



ANSI / API RP-754

Process Safety Performance Indicators for the Refining & Petrochemical Industries

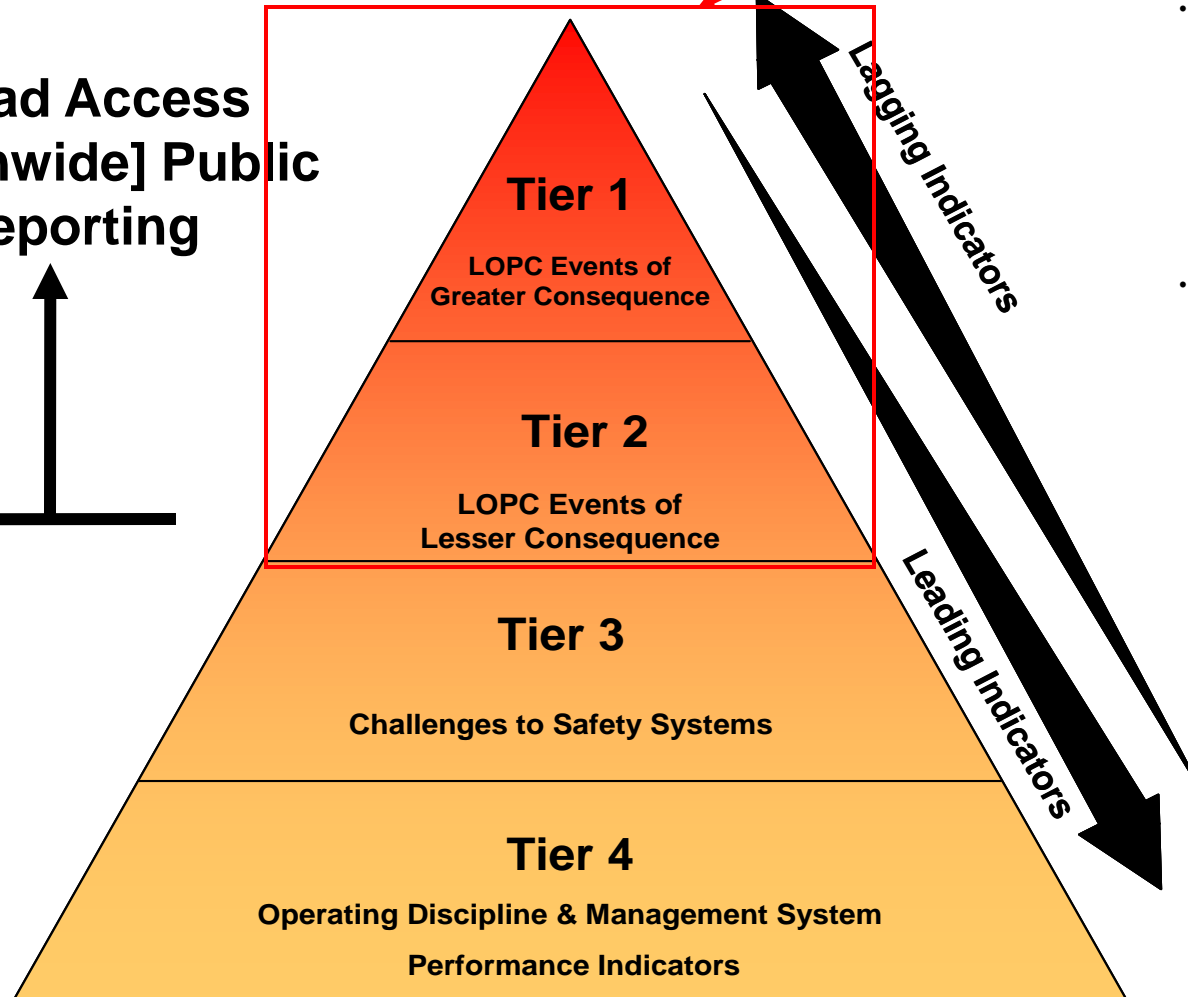
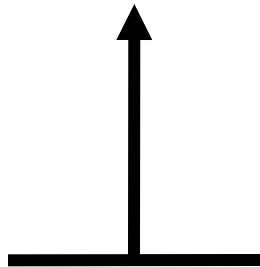
Part 2: Tier 1 and 2 Process Safety Events

Kelly Keim
Vice - Chair API RP-754 Drafting Committee

- Overview of Process Safety Indicator Pyramid
- Criteria for Selection of Tier 1 & 2 Indicators
- Tier 1 Process Safety Event
 - Indicator Definition
 - Definitions of Key Terms
- Identifying a Material Threshold Release Category
- Applicability
- Tier 2 Process Safety Event Indicator Definition
- Data Capture for Tier 1 & 2 Events
- A few example situations

Process Safety Indicator Pyramid

**Broad Access
[Nationwide] Public
Reporting**



- Tiers 1 & 2 are RP-754 standardized definitions
- Tiers 3 & 4 are company defined performance indicators

Criteria for Selection of Tier 1 & 2 Process Safety Indicators

Indicators should be

- Objective, few and simple
- Well defined, capable of being applied consistently across the industry
- Useful to drive process safety performance improvement and learning.
- Useful to all stakeholders and allow internal and external benchmarking
- Statistically valid
 - Provide appropriate sensitivity to be useful for monitoring continuous improvement
 - Capture a sufficient number of events to allow predictive monitoring and identification of performance trends.

Applicability and Events Excluded from Process Safety Reporting

Applicability is not limited to those facilities covered by the OSHA Process Safety Management Standard , 29 CFR 1910.119 or similar national and international regulations.

Events associated with the following activities fall outside the scope of this RP:

- a) Releases from pipeline transfer operations occurring outside the process or storage facility fence line;
- b) Marine transport operations, except when the vessel is connected to the process for the purposes of feedstock or product transfer;
- c) Truck or rail operations, except when the vessel is connected to the process for the purposes of feedstock or product transfer, or if the truck or rail car is being used for on site storage;
- d) Vacuum truck operations, except on-site truck loading or discharging operations, or use of the vacuum truck transfer pump;
- e) Routine emissions that are allowable under permit or regulation;
- f) Office, shop and warehouse building events (e.g. office fires, spills, personnel injury or illness, etc.)

Applicability and Events Excluded from Process Safety Reporting

Events associated with the following activities fall outside the scope of this RP:

- g) Personal safety events (e.g. slips, trips, falls) that are not directly associated with on-site response to a loss of primary containment (LOPC) event;
- h) LOPC events from ancillary equipment not connected to the process (e.g. small sample containers);
- i) Quality assurance (QA), quality control (QC) and research and development (R&D) laboratories (pilot plants are within RP scope);
- j) Retail service stations; and
- k) On-site fueling operations of mobile and stationary equipment (e.g. pick-up trucks, diesel generators, and heavy equipment).

Definitions and Terms

Note that a full section of Definitions and Terms has been included as Section 3.1 in the RP. The definitions in this section govern the use of listed terms as applied to this Recommended Practice.

Tier 1 Process Safety Event

- Tier 1 & 2 Process Safety Events always start with Loss of Primary Containment
 - Loss of Primary Containment: An unplanned or uncontrolled release of material from Primary Containment, including non-toxic and non-flammable materials (e.g. steam, hot condensate, nitrogen or compressed air)
 - Primary Containment: A tank, vessel, pipe, truck, rail car or equipment intended to serve as the primary container or used for processing or transfer of material
 - Secondary Containment: Exists to contain or control a release from primary containment. Secondary containment systems include tank dikes, curbing around process equipment, drainage collection systems, the outer wall of double walled tanks, etc.

Tier 1 Process Safety Event

An unplanned or uncontrolled release of material, including non-toxic and non-flammable materials, from a process which results in one or more of the consequences:

- An employee, contractor or sub-contractor Days Away From Work injury and/or fatality;
- A hospital admission and/or fatality of a third-party;
- An officially declared community evacuation or shelter-in-place;
- A fire or explosion that causes \$25,000 or more of Direct Cost;
- A pressure relief device discharge to the atmosphere whether directly or via a downstream destructive device that results in one or more of the following consequences:
 - Liquid carryover; or
 - Discharge to a potentially unsafe location*; or
 - An on-site shelter-in-place; or
 - Public protective measures (e.g., road closure);
 and a relief device discharge quantity greater than the threshold in Table 1; or
- A release of material from primary containment of greater than the threshold quantities described in Table 1 in any one-hour period.

* A location which results in a potential hazard, such as the formation of flammable mixtures at grade level or on elevated structures, or exposure of personnel to toxic vapors or corrosive chemicals.

Definitions of Key Terms

Fire - An unplanned ignition of flammable or combustible material (solid, liquid, or vapor) either with an open flame or without flame (smoldering). This includes smoldering, charring, smoking, singeing, scorching, carbonizing, uncontained electrical arcing / sparking, or evidence that any of these have occurred.

Explosion - A release of energy that causes a pressure discontinuity or blast wave. Examples include: detonations, deflagrations, and rapid releases of high pressure caused by rupture of equipment or piping.

Direct Cost is only included in relation to Fire and Explosion

Officially Declared Community Evacuation or Shelter-in-place – must be declared by an authorized community official.

Tier 1 Material Release Threshold Quantities

Threshold Release Category	Material Hazard Classification	Threshold Quantity (outdoors)	Threshold Quantity (indoors)
1	TIH Hazard Zone A Materials	5 kg (11 lbs)	2.5 kg (5.5 lbs)
2	TIH Hazard Zone B Materials	25 kg (55 lbs)	12.5 kg (27.5 lbs)
3	TIH Hazard Zone C Materials	100 kg (220 lbs)	50 kg (110 lbs)
4	TIH Hazard Zone D Materials	200 kg (440 lbs)	100 kg (220 lbs)

Indoors refers to the inside of a structure composed of four complete (floor to ceiling) walls, floor and roof.

TIH – Toxic Inhalation Hazard & Zones

TIH – Zone A: Br, HCN, Nickel Carbonyl, Phosgene, Methyl Isocyanate (MIC)

TIH – Zone B: Boron Trifluoride (BF_3), Chlorine, H_2S , Red Fuming Nitric Acid

TIH – Zone C: Hydrogen Chloride (HCl), Hydrogen Fluoride (HF), Sulfur Dioxide (SO_2)

TIH – Zone D: Ammonia (NH_3), Carbon Monoxide (CO), Ethylene Oxide

RP-754 Table 1, Continued

Threshold Release Category	Material Hazard Classification	Threshold Quantity (outdoors)	Threshold Quantity (indoors)
5	Flammable Gases or Liquids with $IBP \leq 35^{\circ}C$ & $FP < 23^{\circ}C$, or Other Packing Group I Materials excluding strong acids/bases	500 kg (1100 lbs)	250 kg (550 lbs)
6	Liquids with $IBP > 35^{\circ}C$ and $Flash Point < 23^{\circ}C$, or Other Packing Group II Materials	1000 kg (2200 lbs) or 7 bbls	500 kg (1100 lbs) or 3.5 bbls
7	Liquids with $FP \geq 23^{\circ}C$ and $\leq 60^{\circ}C$, or Liquids with $Flash Point > 60^{\circ}C$ released at or above FP , or Strong acids/bases, or Other Packing Group III Materials	2000 kg (4400 lbs) or 14 bbls	1000 kg (2200 lbs) or 7 bbls

UN DGL & GHS designations for Flammable Liquids & Gases

Flammable Gases and Liquids with IBP < 35°C

Hydrogen, Methane, Ethane, LPG, Ethylene, isopentane

Flammable Liquids with IBP > 35°C and FP < 23°C

N-pentane, cyclopentane, hexane, cyclohexane, gasoline / petrol, toluene, o-xylene (but not meta or para-xylene), MTBE, ethanol, some crude oils

Flammable Liquids with FP > 23°C and ≤ 60°C

Diesel fuel, most kerosenes, p-xylene, n-butanol, isobutanol, some crude oils

Flammable Liquids with FP > 60°C

Most asphalts, tars, molten sulfur (160°C), ethylene glycol (110°C), propylene glycol (99°C) - (Must be released above Flash Point for Tier 1)

Definitions of Key Terms

Acids / Bases – Strong

Substances with $\text{pH} < 1$ or > 12.5 , or more precisely, substances that cause full thickness destruction of intact skin tissue within an observation period up to 60 minutes starting after the exposure time of three minutes or less, consistent with Globally Harmonized System of Classification and Labeling of Chemicals (GHS) Skin Corrosion Category 1A

Acids / Bases Moderate

Substances with $\text{pH} \geq 1$ and < 2 , or $\text{pH} > 11.5$ and \leq , or more precisely, substances that cause full thickness destruction of intact skin tissue within an observation period up to 14 days starting after the exposure time of 60 minutes or less, but greater than three minutes, consistent with GHS Skin Corrosion Category 1B

Other hazardous materials are assigned to a Packing Group (I, II, or III) depending upon level of hazard.

PG I: Aluminum Alkyls, Some Liquid Amines, Sodium Cyanide, Sodium Peroxide

PG II: Aluminum Chloride, Calcium Carbide, Carbon Tetrachloride, Nicotine, Some Organic Peroxides, Phenol

PG III: Calcium Oxide (CaO), Activated Carbon, Chloroform, Some Organic Peroxides, Sodium Fluoride, Sodium Nitrate, Sulfur

Packing Groups are used where the material's hazards are not represented by its level of Toxic Inhalation Hazard, Flash Point or pH.

Determining Threshold Release Category from US DOT Hazardous Materials Table (172.101)



§ 172.101 HAZARDOUS MATERIALS TABLE—Continued

Sym- bols	Hazardous materials descrip- tions and proper shipping names	Hazard class or Di- vision	Identifica- tion Num- bers	PG	Label Codes	Special provisions (§172.102)	(8) Packaging (§173)	
							Excep- tions	Non- bulk
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8A)	(8B)
	.....	.....		III	3	B1, IB3, T4, TP1, TP29	150	203
	Ethyl acetate	3	UN1173	II	3	IB2, T4, TP1	150	202
	Ethyl acrylate, stabilized	3	UN1917	II	3	IB2, T4, TP1, TP13	150	202
	Ethyl alcohol, see Ethanol .....	.....					
	Ethyl aldehyde, see Acetal- dehyde .....	.....					
	Ethyl amyl ketone	3	UN2271	III	3	B1, IB3, T2, TP1	150	203
	N-Ethyl-N-benzylaniline	6.1	UN2274	III	6.1	IB3, T4, TP1	153	203
	Ethyl borate	3	UN1176	II	3	IB2, T4, TP1	150	202
	Ethyl bromide	6.1	UN1891	II	6.1	IB2, T7, TP2, TP13	None	202
	Ethyl bromoacetate	6.1	UN1603	II	6.1, 3	IB2, T7, TP2	None	202
	Ethyl butyl ether	3	UN1179	II	3	B1, IB2, T4, TP1	150	202
	Ethyl butyrate	3	UN1180	III	3	B1, IB3, T2, TP1	150	203
	Ethyl chloride	2.1	UN1037		2.1	B77, T50	None	322
	Ethyl chloroacetate	6.1	UN1181	II	6.1, 3	IB2, T7, TP2	None	202
	Ethyl chloroformate	6.1	UN1182	I	6.1, 3, 8.	2, A3, A6, A7, B9, B14, B32, B74, N34, T20, TP2, TP13, TP38, TP45	None	227
	Ethyl 2-chloropropionate	3	UN2935	III	3	B1, IB3, T2, TP1	150	203
+	Ethyl chlorothioformate	8	UN2826	II	8, 6.1, 3.	2, B9, B14, B32, B74, T20, TP2, TP38, TP45	None	227
	Ethyl crotonate	3	UN1862	II	3	IB2, T4, TP2	150	202
	Ethyl ether, see Diethyl ether .....	.....					
	Ethyl fluoride or Refrigerant gas R161	2.1	UN2453		2.1		306	304
	Ethyl formate	3	UN1190	II	3	IB2, T4, TP1	150	202
	Ethyl hydroperoxide	Forbidden						
	Ethyl isobutyrate	3	UN2385	II	3	IB2, T4, TP1	150	202
+	Ethyl isocyanate	3	UN2481	I	3, 6.1	1, A7, B9, B14, B30, B72, T22, TP2, TP13, TP38, TP44	None	226

Footnotes Applicable to Table 1

- Threshold quantities given in kg, lb and bbl are not exactly equivalent. Companies should select one unit and use it consistently for all recordkeeping activities.
- Many materials exhibit more than one hazard. Correct placement in Hazard Zone or Packing Group shall follow the rules of DOT 49 CFR 173.2a or UN Recommendations on the Transportation of Dangerous Goods, Section 2.
- For solutions not listed on the UNDG, the anhydrous component shall determine the TIH zone or Packing Group classification. The threshold quantity of the solution shall be back calculated based on the threshold quantity of the dry component weight.
- For mixtures where the UNDG classification is unknown, the fraction of threshold quantity release for each component may be calculated. If the sum of the fractions is equal to or greater than 100%, the mixture exceeds the threshold quantity. Where there are clear and independent toxic and flammable consequences associated with a mixture, the toxic and flammable hazards are calculated independently. See Annex A, Examples 28, 29 and 30.

Tier 2 Process Safety Event

An unplanned or uncontrolled release of any material, including non-toxic and non-flammables materials from a process which results in one or more of the consequences listed below and is not reported in Tier 1:

- An employee, contractor or subcontractor recordable injury; or
- A fire or explosion resulting in greater than or equal to \$2,500 of direct cost to the Company; or
- A pressure relief device (PRD) discharge to atmosphere whether directly or via a downstream destructive device that results in one or more of the following four consequences:
 - Liquid carryover, or
 - Discharge to a potentially unsafe location, or
 - On-site shelter-in-place, or
 - Public protective measures (e.g., road closure);and a PRD discharge quantity greater than the threshold quantities in Table 2; or
- A release of material greater than the threshold quantities described in Table 2 in any one-hour period.

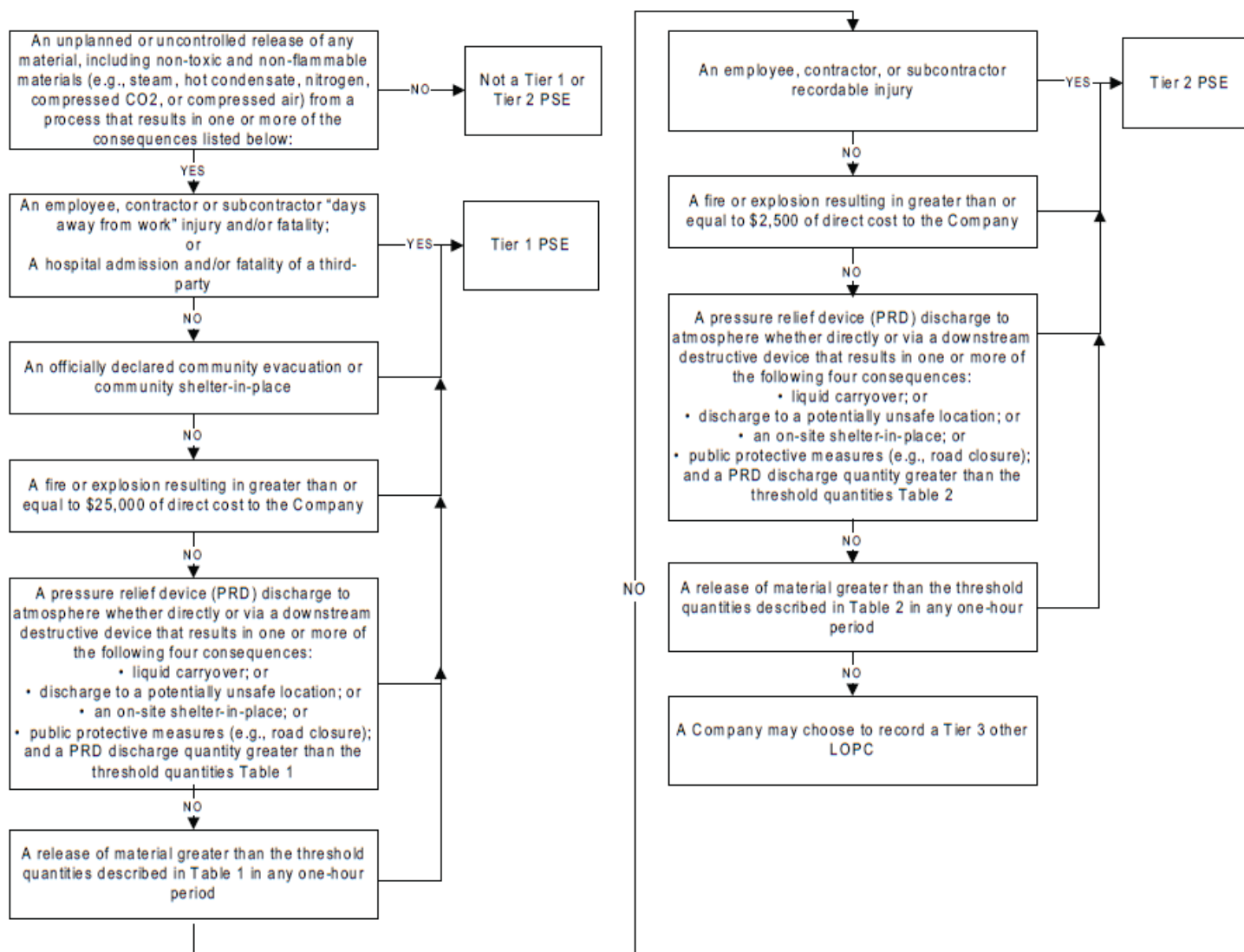
Tier 2 Material Release Threshold Quantities

Threshold Release Category	Material Hazard Classification	Threshold Quantity (outdoors)	Threshold Quantity (indoors)
1	TIH Hazard Zone A Materials	0.5 kg (1.1 lbs)	0.25 kg (.55 lbs)
2	TIH Hazard Zone B Materials	2.5 kg (5.5 lbs)	1.2 kg (2.8 lbs)
3	TIH Hazard Zone C Materials	10 kg (22 lbs)	5 kg (11 lbs)
4	TIH Hazard Zone D Materials	20 kg (44 lbs)	10 kg (22 lbs)

RP-754 Table 2, Continued

Threshold Release Category	Material Hazard Classification	Threshold Quantity (outdoors)	Threshold Quantity (indoors)
5	Flammable Gases or Liquids with IBP $\leq 35^{\circ}\text{C}$ and FP $< 23^{\circ}\text{C}$; or Other Packing Group I Materials	50 kg (100 lbs)	25 kg (50 lbs)
6	Liquids with FP $\geq 23^{\circ}\text{C}$ and $< 60^{\circ}\text{C}$ or Liquids with FP $> 60^{\circ}\text{C}$ released at or above FP; or Other Packing Group II and III Materials excluding moderate acids/bases; or Strong acids and bases	100 kg (220 lbs) or 1 bbl	50 kg (110 lbs) or 0.5 bbl
7	Liquids with FP $> 60^{\circ}\text{C}$ released below FP; or Moderate acids/bases	1000 kg (2200 lbs) or 10 bbl	500 kg (1100 lbs) or 5 bbl

RP 754 Decision Logic Tree



Process Safety Event (PSE) Rates

The Tier 1 PSE Rate is calculated as follows:

$$\text{Tier 1 PSE Rate} = (\text{Total Tier 1 PSE Count} / \text{Total Work Hours}) \times 200,000$$

The Tier 2 PSE Rate is calculated as follows:

$$\text{Tier 2 PSE Rate} = (\text{Total Tier 2 PSE Count} / \text{Total Work Hours}) \times 200,000$$

Total Work Hours includes employee, contractor and subcontractor hours worked minus the hours associated with major construction projects. This is the same number typically used to calculate occupational injury and illness rates.

Site Information

- Type of Facility (NAICS or equivalent international code)
- Corporate Name and Company Name (if different)
- Site Location/Name (country, state/province, city, site name)
- Site Identifier (unique number assigned by data collection group)
- Total work hours

Tier 1 or 2 PSE Information

- Site Identifier
- Identification of Tier 1 or 2 PSE Consequences / Triggers
 - o Harm to people
 - o An officially declared community evacuation or community shelter-in-place
 - o A fire or explosion
 - o A pressure relief device discharge to atmosphere whether directly or via a downstream destructive device
 - o An acute release of flammable, toxic or corrosive chemicals

PSE Related Information

- Type of Process
- Date & Time of Event
- Mode of Operation
- Point of Release
- Type of Material Released

Example Situations

1. A pinhole leak occurs on a sulfuric acid line causing a small, but steady drip. An instrument technician brushes against the line and receives a chemical burn that requires Medical Treatment.

2. 10 bbl spill of gasoline spilled at a steady rate over a period of 1 hour and 30 minutes. Calculations show that the spill rate was 6.7 bbl per hour.

1. The release was unplanned and uncontrolled. It is a Tier 2 PSE because the LOPC resulted in Medical Treatment.

2. The spill rate was less than the threshold of 7 bbl within 1 hour for Tier 1, but more than the 1 bbl threshold for Tier 2. This event is a Tier 2 PSE.

**These are just a few of the examples contained in Annex A of
RP 754**

Example Situations

3. A Maintenance contractor opens a process valve and is sprayed with a very small amount (<10 grams) of sulfuric acid resulting in a second degree burn requiring medical treatment.

4. An underground pipeline within a manufacturing site leaks and releases 1,000 bbl of heavy fuel oil (Flash Point > 60° C) over a period of 3 days. The spill results in contaminated soil that is subsequently remediated.

5. A small quantity of odorous material enters a cooling water system via a tube leak. The material is dispersed into the atmosphere at the cooling tower. An elementary school teacher decides not to conduct recess outside due to a noticeable odor.

3. This is a Tier 2 event since there is no release threshold amount when an LOPC results in medical treatment.

4. This is a Tier 2 event since the release rate exceeded 10 bbls per hour even though the fuel oil never reached the surface.

5. This is not an officially declared evacuation or shelter-in-place and therefore not a Tier 1 or Tier 2 event. The Company may choose to capture this event as a LOPC in its Tier 3 metrics.

Example Situations

#6. There is a unit upset and a properly designed and operating relief valve opens, resulting in a gas release to the atmosphere.

#6. This is NOT a Tier 1 or 2 PSE since vapors and gases released to atmosphere from atmospheric relief are excluded as long as the release did not result in (1) a liquid carryover, (2) on-site activation of a shelter-in-place, or (3) public protective measures being taken, or (4) other indication that the discharge location resulted in a potential hazard.

#7. A chlorine vessel has a relief valve that was identified in a recent HAZOP to be undersized. In the process of making a transfer, the vessel overpressures. A release of 60 lb of chlorine gas occurs through this relief device to a location designed per the requirements of API 521 over a period of 25 minutes.

#7. This is NOT a Tier 1 or 2 PSE regardless of the HAZOP finding, so long as it did not result in (1) a liquid carryover, (2) on-site activation of a shelter-in-place, or (3) public protective measures being taken, or (4) other indication that the discharge location was to a potentially hazardous location.

Example Situations

#8. A pressure relief device (PRD) discharges to a scrubber that vents to atmosphere. The scrubber is overwhelmed by a flow rate greater than its design resulting in a discharge that is detected by fence-line monitoring and a public shelter-in-place order is issued. The PRD release quantity is estimated to be greater than the Tier 1 thresholds.

#8. This is a Tier 1 PSE

Contact Information

Karen Haase, API Staff

API

1220 L Street, NW

Washington, DC 20005

202-682-8478

haasek@api.org

Electronic Download of RP-754

<http://api.org/standards/psstandards>

Questions

