

**American Petroleum Institute  
Guide to Reporting Process Safety Events  
Version 3.1**



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# AMERICAN PETROLEUM INSTITUTE

## GUIDE TO REPORTING PROCESS SAFETY EVENTS

### 1 GENERAL

#### 1.1 Purpose

The purpose of this document is to provide guidance to refining and petrochemical companies on the collection and reporting of process safety events suitable for nationwide public reporting as defined in the American Petroleum Institute (API) Recommended Practice (RP) 754, *Process Safety Performance Indicators for the Refining and Petrochemical Industries*.

*Disclaimer: This document does not preempt any federal, state or local laws regulating process safety. Therefore, nothing contained in this document is intended to alter or determine a Company's compliance responsibilities set forth in the OSHA's Occupational Safety and Health Act of 1970 and/or the OSHA standards themselves, or any other legal or regulatory requirement concerning process safety. The use of the term or concept "process safety" contained in OSHA regulatory requirements, or as the term may be used in other legal or regulatory contexts. In the event of conflict between this document and any OSHA or other legal requirements, the OSHA or other legal requirements should be fully implemented.*

#### 1.2 Objective

The objective of this survey is to collect information on Tier 1 and Tier 2 Process Safety Events (PSEs) as defined in API RP 754 in order to drive performance improvement.

#### 1.3 Applicability

While this survey was developed for the refining and petrochemical industries, it may also be applicable to other industries with operating systems and processes where loss of containment has the potential to cause harm<sup>1</sup>. 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.

This recommended practice applies to the responsible party. At co-located facilities (e.g. industrial park), this recommended practice applies individually to the responsible party and not to the facility as a whole.

Events associated with the following activities fall outside the scope of RP 754 and shall not be included in data collection or reporting efforts:

- a) releases from transportation pipeline operations occurring outside the control of the responsible party;
- b) marine transport operations, except when the vessel is connected or in the process of connecting or disconnecting to the process;
- c) truck or rail transport operations, except when the truck or rail car is connected or in the process of connecting or disconnecting to the process or when the truck or rail car is being used for on-site storage;  
NOTE Active staging is not part of connecting or disconnecting to the process; active staging is not considered on-site storage; active staging is part of transportation.
- d) vacuum truck operations, except on-site truck loading or discharging operations, or use of the vacuum truck transfer pump;
- e) routine emissions from permitted or regulated sources;  
NOTE Upset emissions are evaluated as possible Tier 1 or Tier 2 PSEs per Section 3.1 and 3.2.
- f) office, shop and warehouse building events (e.g. office fires, spills, personnel injury or illness, etc.);
- g) personal safety events (e.g. slips, trips, falls) that are not directly associated with on-site response or exposure 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 included);
- j) new construction that is positively isolated (e.g., blinded or air gapped) from a process prior to commissioning and prior to the introduction of any process fluids and that has never been part of a process;
- k) retail service stations; and
- l) on-site fueling operations of mobile and stationary equipment (e.g. pick-up trucks, diesel generators, and heavy equipment).

### 2 DEFINITIONS

For the purposes of this survey, the following definitions apply:

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<sup>1</sup> To enable consistent application of RP 754 to other refining and petrochemical industry sub segments, informative annexes were created to define the Applicability and Process definition for those sub segments. The user would substitute the content of those annexes for the referenced sections of this document: Appendix E - Petroleum Pipeline & Terminal Operation, Appendix F - Retail Service Stations, Appendix G - Oil & Gas Drilling and Production Operations.

## 2.1

### **acids/bases, moderate**

Substances with  $\text{pH} \geq 1$  and  $< 2$ , or  $\text{pH} > 11.5$  and  $\leq 12.5$ , 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 Globally Harmonized System of Classification and Labeling of Chemicals (GHS) Skin Corrosion Category 1B.<sup>2</sup>

## 2.2

### **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 GHS Skin Corrosion Category 1A.<sup>3</sup>

## 2.3

### **active staging**

Truck or rail cars waiting to be unloaded where the only delay to unloading is associated with physical limitations with the unloading process (e.g., number of unloading stations) or the reasonable availability of manpower (e.g., unloading during daylight hours only, unloading Monday - Friday only), and not with any limitations in available volume within the process. Active staging is part of transportation.

Any truck or rail cars waiting to be unloaded due to limitations in available volume within the process are considered on-site storage.

## 2.4

### **active warehouse**

An on-site warehouse that stores raw materials, intermediates, or finished products used or produced by a process.

From a process perspective, an active warehouse is equivalent to a bulk storage tank. Rather than being stored in a single large container, the raw materials, intermediates, or finished products are stored in smaller containers (e.g., totes, barrels, pails, etc.).

## 2.5

### **acute environmental cost**

Cost of short-term cleanup and material disposal associated with an LOPC with off-site environmental impact.

## 2.6

### **Company**

When designated with a capital C or "the Company," refers to the operating Company in the refining and petrochemical industries, its divisions, or its consolidated affiliates. As used in this RP, the terms "Company" and "Responsible Party" are synonymous.

## 2.7

### **containment, primary**

A tank, vessel, pipe, truck, rail car, or other equipment designed to keep material within it, typically for the purposes of storage, separation, processing, or transfer of material.

## 2.8

### **containment, secondary**

An impermeable physical barrier specifically designed to mitigate the impact of materials that have breached primary containment. Secondary containment systems include, but are not limited to tank dikes, curbing around process equipment, drainage collection systems, the outer wall of open top double walled tanks, etc.

## 2.9

### **contractor and subcontractor**

Any individual not on the Company payroll, whose exposure hours, injuries, and illnesses occur on site.

## 2.10

### **days away from work injury**

Work-related injuries that result in employee person being unfit for work on any day after the day of the injury as determined by a physician or other licensed health professional. "Any day" includes rest days, weekend days, vacation days, public holidays, or days after ceasing

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<sup>2</sup> *United Nations Globally Harmonized System of Classification and Labelling of Chemicals (GHS)*, 1st Edition, New York and Geneva, 2003.

<sup>3</sup> *Ibid.*

employment.

## **2.11**

### **deflagration**

Propagation of a combustion zone at a velocity that is less than the speed of sound in the unreacted medium.

## **2.12**

### **deflagration vent**

An opening in a vessel or duct that prevents failure of the vessel or duct due to overpressure. The opening is covered by a pressure-relieving cover (e.g. rupture disk, explosion disk or hatch).

## **2.13**

### **detonation**

Propagation of a combustion zone at a velocity that is greater than the speed of sound in the unreacted medium.

## **2.14**

### **destructive device**

A flare, scrubber, incinerator, quench drum or other similar device used to mitigate the potential consequences of an engineered pressure relief (e.g., PRD, SIS, or manually initiated emergency depressure) device release.

## **2.15**

### **direct cost**

Cost of repairs or replacement, cleanup, material disposal, and acute environmental cost associated with a fire or explosion. Direct cost does not include indirect costs, such as business opportunity, business interruption and feedstock/product losses, loss of profits due to equipment outages, costs of obtaining or operating temporary facilities, or costs of obtaining replacement products to meet customer demand. Direct cost does not include the cost of repairing or replacing the failed component leading to LOPC, if the component is not further damaged by the fire or explosion. Direct cost does include the cost of repairing or replacing the failed component leading to LOPC if the component failed due to internal or external explosion or overpressure.

## **2.16**

### **employee**

Any individual on the Company payroll whose exposure hours, injuries, and illnesses are routinely tracked by the Company. Individuals not on the Company payroll, but providing services under direct company supervision are also included (e.g. government sponsored interns, secondees, etc.).

## **2.17**

### **explosion**

A release of energy that causes a pressure discontinuity or blast wave (e.g. detonations, deflagrations, and rapid releases of high pressure caused by rupture of equipment or piping).

## **2.18**

### **facility**

The buildings, containers, or equipment that contain a process.

## **2.19**

### **fire**

Any combustion resulting from a LOPC, regardless of the presence of flame. This includes smoldering, charring, smoking, singeing, scorching, carbonizing, or the evidence that any of these have occurred.

## **2.20**

### **flash point (in petroleum products)**

The lowest temperature corrected to a barometric pressure of 101.3 kPa (760 mm Hg), at which application of an ignition source causes the vapors of a specimen of the sample to ignite under specified conditions of test. Test methods include ASTM D92-12b<sup>4</sup>, ASTM D93-

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<sup>4</sup> American Society for Testing and Materials, ASTM D86-12, Standard Test Method for Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure<sup>1</sup>, West Conshohocken, PA

15<sup>5</sup>, D3941-14<sup>6</sup>, D56-05<sup>7</sup>, or other equivalent test methods appropriate to the material characteristics and flash point range specified in the test procedure.

## 2.21

### flammable gas

Any material that is a gas at 35 °C (95 °F) or less and 101.3 kPa (14.7 psi) of pressure and is ignitable when in a mixture of 13 % or less by volume with air or has a flammable range of at least 12 % as measured at 101.3 kPa (14.7 psi).

## 2.22

### hospital admission

Formal acceptance by a hospital or other inpatient health care facility of a patient who is to be provided with room, board, and medical service in an area of the hospital or facility where patients generally reside at least overnight. Treatment in the hospital emergency room or an overnight stay in the emergency room would not by itself qualify as a "hospital admission."

## 2.23

### loss of primary containment LOPC

An unplanned or uncontrolled release of any material from primary containment, including non-toxic and non-flammable materials (e.g. steam, hot water, nitrogen, compressed CO<sub>2</sub>, or compressed air).

## 2.24

### major construction

Large scale investments with specific, one-time project organizations created for design, engineering, and construction of new or significant expansion to existing process facilities.

## 2.25

### material

Substance with the potential to cause harm due to its chemical (e.g. flammable, toxic, corrosive, reactive, asphyxiate) or physical (e.g. thermal, pressure) properties.

## 2.26

### moderate acids/bases

See acids/bases, moderate.

## 2.27

### normal boiling point

The temperature at which boiling occurs under a pressure of 101.3 kPa (760 mm Hg). Test methods include ASTM E1719-12<sup>8</sup>, ASTM D86-12<sup>9</sup>, or other equivalent test method. For the purpose of this RP, the terms normal boiling point and initial boiling point are considered synonymous.

## 2.28

### office building

Buildings intended to house office workers (e.g. administrative or engineering building, affiliate office complex, etc.).

## 2.29

### officially declared

A declaration by a recognized community official (e.g. fire, police, civil defense, emergency management) or delegate (e.g. Company official) authorized to order the community action (e.g. shelter-in-place, evacuation).

## 2.30

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<sup>5</sup> American Society for Testing and Materials, ASTM D93-15, *Standard Test Method for Flash Point by Pensky-Martens Closed Cup Tester*, West Conshohocken, PA

<sup>6</sup> American Society for Testing and Materials, ASTM D3941-14, *Standard Test Method for Flash Point by the Equilibrium Method With a Closed-Cup Apparatus*, West Conshohocken, PA

<sup>7</sup> American Society for Testing and Materials, ASTM D56-05, *Standard Test Method for Flash Point by Tag Closed Cup Tester*, West Conshohocken, PA

<sup>8</sup> American Society for Testing and Materials, ASTM E1719-12, *Standard Test Method for Vapor Pressure of Liquids by Ebulliometry*, West Conshohocken, PA

<sup>9</sup> American Society for Testing and Materials, ASTM D86-12, *Standard Test Method for Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure*<sup>1</sup>, West Conshohocken, PA

## **pilot plant**

An assembly of process equipment which is intended to produce the equivalent of a salable product, whether an actual sale occurs or not. The purpose of a pilot plant is to optimize the chosen chemistry, quantify process parameters to facilitate design and construction of a commercial scale facility, and determine product purity and quality standards.

### **2.31**

#### **precautionary (evacuation, public protective measure, shelter-in-place)**

A measure taken from an abundance of caution.

For example, a company may require all workers to shelter-in-place in response to an LOPC independent of or prior to any assessment (e.g., wind direction, distance from the LOPC, etc.) of the potential hazard to those worker.

For example, a recognized community official (e.g., fire, police, civil defense, emergency management) may order a community shelter-in-place, evacuation, or public protective measure (e.g., road closure) in the absence of information from a company experiencing a process safety event, or 'just in case' the wind direction changes, or due to the sensitive nature of the potentially affected population (e.g., school children, the elderly).

### **2.32**

#### **precautionary evacuation**

See precautionary (evacuation, public protective measure, shelter-in-place).

### **2.33**

#### **precautionary public protective measure**

See precautionary (evacuation, public protective measure, shelter-in-place).

### **2.34**

#### **precautionary shelter-in-place**

See precautionary (evacuation, public protective measure, shelter-in-place).

### **2.35**

#### **pressure relief device PRD**

A device designed to open and relieve excess pressure (e.g. safety valve, thermal relief, rupture disk, rupture pin, deflagration vent, pressure/vacuum vents, etc.).

NOTE A PRD discharge is a LOPC due to the nature of the unplanned release. The PRD discharge is evaluated against the consequence criteria to determine if it is a Tier 1 or Tier 2 PSE.

### **2.36**

#### **primary containment**

See containment, primary.

### **2.37**

#### **process**

Production, distribution, storage, utilities, or pilot plant facilities used in the manufacture of petrochemical and petroleum refining products. This includes process equipment (e.g. reactors, vessels, piping, furnaces, boilers, pumps, compressors, exchangers, cooling towers, refrigeration systems, etc.), storage tanks, active warehouses, ancillary support areas (e.g. boiler houses and waste water treatment plants), on-site remediation facilities, and distribution piping under control of the Company.

### **2.38**

#### **process safety**

A disciplined framework for managing the integrity of hazardous operating systems and processes by applying good design principles, engineering, and operating and maintenance practices.

It deals with the prevention and control of events that have the potential to release hazardous materials or energy. Such events can cause toxic effects, fire, or explosion and could ultimately result in serious injuries, property damage, lost production and environmental impact.

### **2.39**

#### **Process safety event (PSE)**

An unplanned or uncontrolled release of any material including non-toxic and non-flammable materials (e.g. steam, hot water, nitrogen, compressed CO<sub>2</sub>, or compressed air) from a process, or an undesired event or condition that, under slightly different circumstances, could have resulted in a release of a material.

## 2.40

### public receptors

Offsite residences, institutions (e.g. schools, hospitals), industrial, commercial, and office buildings, parks, or recreational areas where members of the public could potentially be exposed to toxic concentrations, radiant heat, or overpressure, as a result of a LOPC.

## 2.41

### rainout

Two-phase relief (vapor and entrained liquid) from a vent or relief device with the vapor phase dispersing to the atmosphere and the remaining liquid falling to grade or ground.

## 2.42

### recordable injury

A work-related injury that results in any of the following: death, days away from work, restricted work or transfer to another job, medical treatment beyond first aid, loss of consciousness or a significant injury diagnosed by a physician or other licensed health professional. This is an abridged version of the definition used to report days away from work injuries for OSHA.<sup>10</sup>

## 2.43

### Research and Development (R&D) laboratory

A facility that provides controlled conditions in which scientific or technological research, experiments, and measurement may be performed.

## 2.44

### responsible party

The party charged with operating the facility in a safe, compliant, and reliable manner is the responsible party. In some countries or jurisdictions, the responsible party may be called the 'duty holder' or the party with regulatory reporting responsibility. As used in this RP, the terms "Responsible Party" and "Company" are synonymous.

NOTE The responsible party is determined prior to any process safety event. The responsible party could be the facility owner or the facility operator, depending upon the relationship between the two. Is the owner or the operator responsible for the performance of the facility? Who is responsible for developing and implementing prevention programs? Who is responsible for performing the investigation and identifying and implementing corrective action following a process safety event?

## 2.45

### safety instrumented system

an instrumented protection layer whose purpose is to take the process to a safe state when predetermined conditions are violated.

## 2.46

### secondary containment

See containment, secondary.

## 2.47

### shelter-in-place

The use of a structure and its indoor atmosphere to temporarily separate individuals from a potentially hazardous outdoor atmosphere.

## 2.48

### strong acids/bases

see acids/bases, strong.

## 2.49

### third-party

Any individual other than an employee, contractor, or subcontractor of the Company [e.g., visitors, non-contracted delivery drivers (e.g. UPS, U.S. Mail, Federal Express), residents, etc.].

## 2.50

### tolling operation

A company with specialized equipment that processes raw materials or semi-finished goods for another company.

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<sup>10</sup> U.S. Department of Labor, Occupational Safety and Health Administration, OSHA Recordkeeping Handbook: The Regulation and Related Interpretations for Recording and Reporting Occupational Injuries and Illnesses, OSHA 3245-01R, 2005.

## 2.51

### total work hours

Total 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.

## 2.52

### United Nations Dangerous Goods (UNDG)

A classification system used to evaluate the potential hazards of various chemicals when released, which is used by most international countries as part of the product labeling or shipping information<sup>11</sup>. In the United States, these hazard categories are defined in U.S. Department of Transportation (DOT) regulations 49 *CFR* 173.2a<sup>12</sup> and listed in 49 *CFR* 172, Subpart B<sup>13</sup>.

## 2.53

### UNDG Class 2, Division 2.2 (non-flammable, non-toxic gases)

Non-flammable, non-toxic gases (corresponding to the groups designated asphyxiant or oxidizing), excluding air.

Asphyxiant – Gases which are non-oxidizing, non-flammable, and non-toxic, which dilute or replace oxygen normally in the atmosphere.

Oxidizing – Gases, which may, generally by providing oxygen, cause or contribute to the combustion of other material more than air does. These gases are pure gases or gas mixtures with an oxidizing power greater than 23.5% as determined by a method specified in ISO 10156:2010(E)<sup>14</sup>.

## 2.54

### unsafe location

An atmospheric pressure relief device discharge point or downstream destructive device (e.g. flare, scrubber) discharge point that results in a potential hazard to personnel, due to their proximity, such as the formation of flammable mixtures at ground level or on elevated work structures, presence of toxic or corrosive materials at ground or on elevated work structures, or thermal radiation effects from ignition of relief streams at the point of emission as specified in API 521 Section 5.8.4.4.<sup>15</sup>

## 3 REPORTABLE PROCESS SAFETY EVENT

A reportable PSE is an unplanned or uncontrolled release of any material including non-toxic and non-flammable materials (e.g., steam, hot water, nitrogen, compressed CO<sub>2</sub>, or compressed air) from a process that meets the definitions for Tier 1 or Tier 2 Indicators below.

### 3.1 Tier 1 Indicator Definition and Consequences

A Tier 1 Process Safety Event (T-1 PSE) is a loss of primary containment (LOPC) with the greatest consequence as defined by API RP 754. A T-1 PSE is an unplanned or uncontrolled release of any material, including non-toxic and non-flammable materials (e.g. steam, hot water, nitrogen, compressed CO<sub>2</sub>, or compressed air), from a process that results in one or more of the consequences listed below:

**NOTE** Some non-toxic and non-flammable materials (e.g., steam, hot water, or compressed air) have no threshold quantities and are only included in this definition because of their potential to result in one of the other consequences.

**NOTE** A pressure relief device (PRD), safety instrumented system (SIS), or manually initiated emergency depressure discharge is a LOPC due to the unplanned nature of the release. The determination of Tier 1 PSE is based upon the criteria described below.

**NOTE** An internal fire or explosion that causes a LOPC from a process triggers an evaluation of the Tier 1 consequences. The LOPC does not have to occur first.

- an employee, contractor or subcontractor “days away from work” injury and/or fatality;
- a hospital admission and/or fatality of a third-party;
- an officially declared community evacuation or community shelter-in-place including precautionary community evacuation or community shelter-in-place;
- fire or explosion damage greater than or equal to \$100,000 of direct cost;
- an engineered pressure relief (e.g., PRD, SIS, or manually initiated emergency depressure) discharge, of a quantity greater than or equal to the threshold quantities in Table 1<sup>16</sup> in any one-hour period, to atmosphere whether directly or via a downstream destructive device that results in one or more of the following four consequences:

<sup>11</sup> United Nations Economic Commission for Europe (UNECE), ECE/TRANS/202, Vol. I and II (“ADR 2009”), *European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR)*, 2009.

<sup>12</sup> Department of Transportation, 49 *CFR* 173.2a—*Classification of a Material Having More Than One Hazard*.

<sup>13</sup> U.S. Department of Transportation, 49 *CFR*, Part 172, *Subpart B—Table of Hazardous Materials and Special Provisions*.

<sup>14</sup> International Organization for Standardization, ISO 10156:2010(E) Third Edition, Gases and gas mixtures — Determination of fire potential and oxidizing ability for the selection of cylinder valve outlets, Geneva Switzerland, 2010.

<sup>15</sup> American Petroleum Institute, ANSI/API Standard 521/ISO 23251 Sixth Edition, *Pressure-relieving and Depressuring Systems*.

<sup>16</sup> See Appendix A, Material Release Threshold Quantities

- rainout;
  - discharge to a potentially unsafe location;
  - an on-site shelter-in-place or on-site evacuation, excluding precautionary on-site shelter-in-place or on-site evacuation;
  - public protective measures (e.g. road closure) including precautionary public protective measures.
- an upset emission from a permitted or regulated source of a quantity greater than or equal to the threshold quantities in Table 1<sup>17</sup> in any one-hour period, that results in one or more of the following four consequences:
- rainout;
  - discharge to a potentially unsafe location;
  - an on-site shelter-in-place or on-site evacuation, excluding precautionary on-site shelter-in-place or on-site evacuation;
  - public protective measures (e.g., road closure) including precautionary public protective measures.
- a release of material greater than or equal to the threshold quantities described in Table 1 in any one-hour period.

### 3.2 Tier 2 Indicator Definition and Consequences

A Tier 2 Process Safety Event (T-2 PSE) is a LOPC with lesser consequence. A T-2 PSE is an unplanned or uncontrolled release of any material, including non-toxic and non-flammable materials (e.g. steam, hot water, nitrogen, compressed CO<sub>2</sub>, or compressed air), from a process that results in one or more of the consequences listed below and is not reported as a Tier 1 PSE:

**NOTE** Some non-toxic and non-flammable materials (e.g. steam, hot water, or compressed air) have no threshold quantities and are only included in this definition because of their potential to result in one of the other consequences.

**NOTE** A pressure relief device (PRD), safety instrumented system (SIS), or manually initiated emergency depressure discharge is a LOPC due to the unplanned nature of the release. The determination of Tier 2 PSE is based upon consequences and threshold quantities described below.

**NOTE** An internal fire or explosion that causes a LOPC from a process triggers an evaluation of the Tier 2 consequences. The LOPC does not have to occur first.

- an employee, contractor or subcontractor recordable injury;
- a fire or explosion damage greater than or equal to \$2,500 of direct cost;
- an engineered pressure relief (PRD, SIS, or manually initiated emergency depressure) device discharge, of a quantity greater than or equal to the threshold quantities in Table 2<sup>18</sup> in any one-hour period, to atmosphere whether directly or via a downstream destructive device that results in one or more of the following four consequences:
  - rainout;
  - discharge to a potentially unsafe location;
  - an on-site shelter-in-place or on-site evacuation, excluding precautionary on-site shelter-in-place or on-site evacuation;
  - public protective measures (e.g. road closure) including precautionary public protective measures.
- an upset emission from a permitted or regulated source, of a quantity greater than or equal to the threshold quantities in Table 2<sup>19</sup> in any one-hour period, that results in one or more of the following four consequences:
  - rainout;
  - discharge to a potentially unsafe location;
  - an on-site shelter-in-place or on-site evacuation, excluding precautionary on-site shelter-in-place or on-site evacuation;
  - public protective measures (e.g., road closure) including precautionary public protective measures.
- a release of material greater than or equal to the threshold quantities described in Table 2 in any one- hour period.

<sup>17</sup> Ibid.

<sup>18</sup> See Appendix A, Material Release Threshold Quantities

<sup>19</sup> Ibid.

### 3.3 Calculation of a PSE Rate

The Tier 1 PSE Rate shall be calculated as follows:

Tier 1 PSE Rate <sub>200,000</sub> = (Total Tier 1 PSE Count / Total Work Hours<sup>20</sup>) x 200,000, or

Tier 1 PSE Rate <sub>1,000,000</sub> = (Total Tier 1 PSE Count / Total Work Hours) x 1,000,000

The Tier 2 PSE Rate shall be calculated as follows:

Tier 2 PSE Rate <sub>200,000</sub> = (Total Tier 2 PSE Count / Total Work Hours) x 200,000

Tier 2 PSE Rate <sub>1,000,000</sub> = (Total Tier 2 PSE Count / Total Work Hours) x 1,000,000

The choice of calculating PSE Rate utilizing either a 200,000 or 1,000,000 man hour multiplier should be consistent with the basis for calculating the Company's occupational injury rate or public reporting conventions.

NOTE Total work hours include employees and contractors (see definitions 2.16 and 2.9, Terms and Definitions).

## 4 REPORTING TO API

During the first quarter of each calendar year, participating companies will be asked to submit data for the previous calendar year. The annual report will provide the information contained in Appendix B of this document.

An annual Process Safety Report will be issued annually by API. It will present aggregate industry data that will reflect the total number of events separated by refining and petrochemical facilities, for U.S. data. The report will also contain a brief explanation of the data and its overall meaning.

## 5 REFERENCES

For complete information on Tier 1 and Tier 2 Process Safety Indicator Definitions and examples of PSEs:

- ANSI/API Recommended Practice 754, *Process Safety Indicators for the Refining and Petrochemical Industries, Second Edition* 2016.

For more information on chemical listings:

- AIChE, Center for Chemical Process Safety, *Process Safety Leading and Lagging Metrics*, Appendix B: Additional Information Regarding UN Dangerous Goods Classification and Listing of Chemicals, 2011.<sup>21</sup>
- UNECE, ECE/TRANS/202, Vol. I and II ("ADR 2009"), *European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR)*.<sup>22</sup>
- *United National Globally Harmonized System of Classification and Labelling of Chemicals (GHS)*.<sup>23</sup>
- U.S. DOT, 49 CFR, Part 172, *Subpart B—Table of Hazardous Materials and Special Provisions*.<sup>24</sup>
- U.S. DOT, 49 CFR 173.2a—Classification of a Material Having More Than One Hazard.<sup>25</sup>

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<sup>20</sup> Total Work Hours was chosen as the normalizing factor for PSE Rate as a balance between ready availability of the data, relevance to harm, and applicability to various refining and petrochemical operations. Other suggested normalizers such as throughput, Dow Fire & Explosion Index, etc. did not strike this balance.

<sup>21</sup> Center for Chemical Process Safety, *Guidelines for Process Safety Metrics*, American Institute of Chemical Engineers, New York, 2011.

<sup>22</sup> United Nations Economic Commission for Europe (UNECE), ECE/TRANS/202, Vol. I and II ("ADR 2009"), *European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR)*, 2009.

<sup>23</sup> *United National Globally Harmonized System of Classification and Labelling of Chemicals (GHS)*, 1<sup>st</sup> Edition, New York and Geneva, 2003.

<sup>24</sup> U.S. Department of Transportation, 49 CFR, Part 172, *Subpart B—Table of Hazardous Materials and Special Provisions*.

<sup>25</sup> U.S. Department of Transportation, 49 CFR 173.2a—Classification of a Material Having More Than One Hazard.

**APPENDIX A**

**MATERIAL THRESHOLD QUANTITIES**

NOTE In determining the Threshold Release Category, a Company may choose to use either the properties of the released material based upon laboratory analysis at the time of release or the properties documented in a safety data sheet. Companies should be consistent in their approach for all LOPC's.

**Table 1—Tier 1 Material Release Threshold Quantities**

Threshold Release Category	Material Hazard Classification <sup>a,c,d,e,f</sup>	Threshold Quantity (outdoor release)	Threshold Quantity (indoor <sup>b</sup> release)
T1-1	TIH Zone A Materials	≥ 5 kg (11 lb)	≥ 0.5 kg (1.1 lb)
T1-2	TIH Zone B Materials	≥ 25 kg (55 lb)	≥ 2.5 kg (5.5 lb)
T1-3	TIH Zone C Materials	≥ 100 kg (220 lb)	≥ 10 kg (22 lb)
T1-4	TIH Zone D Materials	≥ 200 kg (440 lb)	≥ 20 kg (44 lb)
T1-5	Flammable Gases, or Liquids with Initial Normal Point ≤ 35 °C (95 °F) and Flash Point < 23 °C (73 °F), or Other Packing Group I Materials (excluding acids/bases)	≥ 500 kg (1100 lb)	≥ 50 kg (110 lb)
T1-6	Liquids with Normal Boiling Point > 35 °C (95 °F) and Flash Point < 23 °C (73°F), or Other Packing Group II Materials (excluding acids/bases)	≥ 1000 kg (2200 lb) or ≥ 7 bbl	≥ 100 kg (220 lb) or ≥ 0.7 bbl
T1-7	Liquids with Flash Point ≥ 23 °C (73 °F) and ≤ 60 °C (140 °F), or Liquids with Flash Point > 60 °C (140 °F) released at a temperature at or above Flash Point, or strong acids/bases (see definition 2.2, Terms and Definitions), or Other Packing Group III Materials	≥ 2000 kg (4400 lb) or ≥ 14 bbl	≥ 200 kg (440 lb) or ≥ 1.4 bbl

It is recognized that threshold quantities given in kg and lb or in lb and bbl are not exactly equivalent. Companies should select one of the pair and use it consistently for all recordkeeping activities.

In determining the Threshold Release Category for a material, one should first use the toxic (TIH Zone) or flammability (Flash Point and Boiling Point) or corrosiveness (Strong Acid or Base vs. Moderate Acid or Base) characteristics. Only when the hazard of the material is not expressed by those simple characteristics (e.g., reacts violently with water) is the UNGL Packing Group used.

- a 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. See Annex F<sup>26</sup>.
- b A structure composed of four complete (floor to ceiling) walls, floor, and roof.
- c 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.
- d 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 the mixture, the toxic and flammable hazards are calculated independently. See Annex E<sup>27</sup> PSE Examples & Questions 49-53.
- e A LOPC of Liquids with Flash Point > 60 °C (140 °F) and □ 93 °C (200 °F) released at a temperature below Flash Point cannot be Tier 1 PSE based upon quantity released no matter the volume.
- f A LOPC of a moderate acid/base cannot be Tier 1 PSE based upon quantity released no matter the volume.

<sup>26</sup> API Recommended Practice 754

<sup>27</sup> Ibid.

**Table 2—Tier 2 Material Release Threshold Quantities**

Threshold Release Category	Material Hazard Classification <sup>a,c,d,e,f</sup>	Threshold Quantity (outdoor release)	Threshold Quantity (indoorb release)
T2-1	TIH Zone A Materials	≥ 0.5 kg (1.1 lb)	≥ 0.25 kg (0.55 lb)
T2-2	TIH Zone B Materials	≥ 2.5 kg (5.5 lb)	≥ 1.25 kg (2.75 lb)
T2-3	TIH Zone C Materials	≥ 10 kg (22 lb)	≥ 5 kg (11 lb)
T2-4	TIH Zone D Materials	≥ 20 kg (44 lb)	≥ 10 kg (22 lb)
T2-5	Flammable Gases, or Liquids with Normal Boiling Point ≤ 35 °C (95 °F) and Flash Point < 23 °C (73 °F), or Other Packing Group I Materials (excluding acids/bases)	≥ 50 kg (110 lb)	≥ 25 kg (55 lb)
T2-6	Liquids with Normal Boiling Point > 35 °C (95 °F) and Flash Point < 23 °C (73°F), or Other Packing Group II Materials (excluding acids/bases)	≥ 100 kg (220 lb) or 0.7 bbl	≥ 50 kg (110 lb) or 0.35 bbl
T2-7	Liquids with Flash Point ≥ 23 °C (73 °F) and ≤ 60 °C (140 °F), or, Liquids with Flash Point > 60 °C (140 °F) released at a temperature at or above Flash Point, or strong acids/bases (see definition 2.2, Terms and Definitions), or UNDG Class 2, Division 2.2 (non-flammable, non-toxic gases) excluding air, or Other Packing Group III Materials	≥ 200 kg (440 lb) or ≥ 1.4 bbl	≥ 100 kg (220 lb) or ≥ 0.7 bbl
T2-8	Liquids with Flash Point > 60 °C (140 °F) and □ 93 °C (200 °F) released at a temperature below Flash Point, or Moderate acids/bases (see definition 2.1, Terms and Definitions)	≥ 1000 kg (2200 lb) or ≥ 7 bbl	≥ 500 kg (1100 lb) or ≥ 3.5 bbl

It is recognized that threshold quantities given in kg and lb or in lb and bbl are not exactly equivalent. Companies should select one of the pair and use it consistently for all recordkeeping activities.

In determining the Threshold Release Category for a material, one should first use the toxic (TIH Zone) or flammability (Flash Point and Boiling Point) or corrosiveness (Strong Acid or Base vs. Moderate Acid or Base) characteristics. Only when the hazard of the material is not expressed by those simple characteristics (e.g., reacts violently with water) is the UNDGL Packing Group used.

a 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. See Annex F<sup>28</sup>.

b A structure composed of four complete (floor to ceiling) walls, floor and roof.

c 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.

d 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 the mixture, the toxic and flammable hazards are calculated independently. See Annex E<sup>29</sup>, PSE Examples & Questions 49-53.

e A LOPC of Liquids with Flash Point > 60 °C (140 °F) and □ 93 °C (200 °F) released at a temperature below Flash Point cannot be Tier 1 PSE based upon quantity released no matter the volume.

f A LOPC of a moderate acid/base cannot be Tier 1 PSE based upon quantity released no matter the volume.

RP 754 Annex E<sup>30</sup>, PSE Examples & Questions provides a wide variety of examples to assist companies in determining the proper classification of Tier 1 and Tier 2 PSE.

<sup>28</sup> API Recommended Practice 754

<sup>29</sup> Ibid.

<sup>30</sup> API Recommended Practice 754

RP 754 Annex F<sup>31</sup>, Listing of Chemicals Sorted by Threshold Quantity provides a link to a comprehensive list of chemicals with associated release threshold quantities that has been adopted for this RP. Annex F also describes the thought process used to assign Packing Groups, Hazard Zones, and threshold quantities for flammable and toxic materials.

RP 754 Annex G<sup>32</sup>, Application of Threshold Release Categories to Multicomponent Releases provides guidance on threshold release category determination for a variety of multicomponent streams.

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<sup>31</sup> Ibid.

<sup>32</sup> Ibid.

## APPENDIX B

### PSE DATA CAPTURE INFORMATION<sup>33</sup>

#### Facility Information

The following information shall be captured for each facility:

- a) type of facility (NAICS or equivalent international code);
- b) corporate name;
- c) company name (if different);
- d) facility location/name (country, state/province, city, facility name);
- e) facility identifier(s) (unique number(s) assigned by data collection groups);
- f) total work hours:
  - 1) total hours worked by employees, and
  - 2) total hours worked by contractors and subcontractors.

#### Tier 1 PSE Information

The following information shall be captured for each Tier 1 PSE:

- a) facility identifier;
- b) Tier 1 PSE consequences/triggers, each Tier 1 PSE will have one or more of the following consequences (check all that apply):

**NOTE** Since a Tier 1 Process Safety Event can result in one or more consequences, the total count of consequences will be equal to or greater than the total count of Tier 1 PSEs.

- 1) an employee, contractor, or subcontractor "days away from work" injury and/or fatality:
  - i) number of employee days away from work injuries,
  - ii) number of employee fatalities,
  - iii) number of contractor or subcontractors days away from work injuries,
  - iv) number of contractor or subcontractor fatalities;
- 2) a third party (non-employees/contractor, community members) hospital admission and/or fatality:
  - i) number of third-party hospital admissions,
  - ii) number of third-party fatalities;
- 3) an officially declared community evacuation or community shelter-in-place including precautionary community evacuation or community shelter-in-place;
- 4) a fire or explosion causing \$100,000 or more in direct cost:
  - i) fire,
  - ii) explosion;
- 5) an engineered pressure relief (e.g., PRD, SIS, or manually initiated emergency depressure) discharge, of a quantity greater than or equal to the threshold quantities in Table 1 in any one-hour period, to atmosphere whether directly or via a downstream destructive device (check one):
  - i) PRD, SIS, or manually initiated emergency depressure device directly to atmosphere,
  - ii) PRD, SIS, or manually initiated emergency depressure device to atmosphere via a downstream destructive device;that results in one or more of the following four consequences (check all that apply):
  - i) rainout,
  - ii) discharge to a potentially unsafe location,
  - iii) an on-site shelter-in-place or on-site evacuation, excluding precautionary on-site shelter-in-place or on-site evacuation,
  - iv) public protective measures (e.g., road closure) including precautionary public protective measures;
- 6) an upset emission from a permitted or regulated source, of a quantity greater than or equal to the threshold quantities in

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<sup>33</sup> API Recommended Practice 754

Table 1 in any one-hour period, that results in one or more of the following four consequences (check all that apply):

- i) rainout;
  - ii) discharge to a potentially unsafe location;
  - iii) an on-site shelter-in-place or on-site evacuation, excluding precautionary on-site shelter-in-place or on-site evacuation;
  - iv) public protective measures (e.g., road closure) including precautionary public protective measures.
- 7) a release of flammable, combustible, toxic, corrosive, or UNDG Class 2, Division 2.2 material from primary containment (check one):
- i) Tier 1 (Table 1) Threshold Release Category 1,
  - ii) Tier 1 (Table 1) Threshold Release Category 2,
  - iii) Tier 1 (Table 1) Threshold Release Category 3,
  - iv) Tier 1 (Table 1) Threshold Release Category 4,
  - v) Tier 1 (Table 1) Threshold Release Category 5,
  - vi) Tier 1 (Table 1) Threshold Release Category 6,
  - vii) Tier 1 (Table 1) Threshold Release Category 7.
- Release location (check one):
- (a) outdoor release,
  - (b) indoor release.
- 8) Tier 1 PSE severity weight<sup>34</sup> (optional)

## Tier 2 PSE Information

The following information shall be captured for each Tier 2 PSE:

- a) facility identifier;
- b) Tier 2 PSE consequences/triggers; each Tier 2 PSE will have one or more of the following consequences (check all that apply) :

NOTE Since a Tier 2 Process Safety Event can result in one or more consequences, the total count of consequences will be equal to or greater than the total count of Tier 2 PSEs.

- 1) an employee, contractor, or subcontractor recordable injury:
  - i) number of employee recordable injuries,
  - ii) number of contractor or subcontractor recordable injuries;
- 2) a fire or explosion causing \$2,500 or more in direct cost:
  - i) fire,
  - ii) explosion;
- 3) an engineered pressure relief (PRD, SIS, or manually initiated emergency depressure) discharge, of a quantity greater than or equal to the threshold quantities in Table 2 in any one-hour period to atmosphere whether directly or via a downstream destructive device (check one):
  - i) PRD, SIS, or manually initiated emergency depressure device directly to atmosphere,
  - ii) PRD, SIS, or manually initiated emergency depressure device to atmosphere via a downstream destructive device;

that results in one or more of the following four consequences (check all that apply):

- i) rainout,
  - ii) discharge to a potentially unsafe location,
  - iii) an on-site shelter-in-place or on-site evacuation excluding precautionary on-site shelter-in-place or precautionary on-site evacuation,
  - iv) public protective measures (e.g. road closure) including precautionary public protective measures;
- 4) an upset emission from a permitted or regulated source, of a quantity greater than or equal to the threshold quantities in Table 2 in any one-hour period, that results in one or more of the following four consequences (check all that apply):

<sup>34</sup> See Appendix D, Tier 1 PSE Severity Weighting

- i) rainout;
  - ii) discharge to a potentially unsafe location;
  - iii) an on-site shelter-in-place or on-site evacuation, excluding precautionary on-site shelter-in-place or on-site evacuation;
  - iv) public protective measures (e.g., road closure) including precautionary public protective measures.
- 5) a release of flammable, combustible, toxic, corrosive, or UNDG Class 2, Division 2.2 material from primary containment (check one):
- i) Tier 2 (Table 2) Threshold Release Category 1,
  - ii) Tier 2 (Table 2) Threshold Release Category 2,
  - iii) Tier 2 (Table 2) Threshold Release Category 3,
  - iv) Tier 2 (Table 2) Threshold Release Category 4,
  - v) Tier 2 (Table 2) Threshold Release Category 5,
  - vi) Tier 2 (Table 2) Threshold Release Category 6,
  - vii) Tier 2 (Table 2) Threshold Release Category 7
  - viii) Tier 2 (Table 2) Threshold Release Category 8.
- Release location (check one):
- i) outdoor release,
  - ii) indoor release.

## PSE Related Information

The following information is useful in data analysis and shall be captured for each Tier 1 and Tier 2 PSE:

- ❖ Date and Time of Event
- ❖ Event Description
  - Briefly describe “what happened” and “why”. For example: “Leak on a fractionator reflux line due to external corrosion caused from a leak in a process water line dripping on the reflux line.” Another example: “LOPC from overfilling a small caustic tank due to malfunctioning level indication.”
- ❖ Comments (optional)
- ❖ Type of Process:
  - Refining:
    - Active Warehouse
    - Alkylation, HF
    - Alkylation, Sulfuric
    - Bitumen / Resid / Asphalt
    - Calcining
    - Coking
    - Crude / Vacuum Distillation
    - FCC
    - Flares / Flare Systems / Flare Gas Recovery
    - Gas and Liquid Desulfurization / Treating (H<sub>2</sub>S absorbers, amine systems, Merox)
    - Hydrocracking
    - Hydrogen
    - Hydrotreating
    - Isomerization
    - Loading / Unloading (truck or rail)
    - Marine / Jetty / Wharf
    - Pilot Plant
    - Reforming

- Sulfur Recovery
- Tank Farm / Storage Facility / Offsites / Storage and Transfer Piping
- Utilities / Steam Plant / Cogeneration
- Vapor Recovery/Light Ends
- Waste/Wastewater Handling, Treatment or Disposal
- Other (describe);
- Petrochemical:
  - Acetic Acid and Derivatives
  - Active Warehouse
  - Amines Derivatives
  - Aromatics Derivatives (cumene, dis-proportionation, aromatic isomerization, linear alkylbenzene)
  - Benzene
  - Butadiene
  - Butane
  - Cyclohexane
  - Dehydrogenation (propylene, butylenes)
  - Diisocyanates (TDA, MDA, IPDA, etc.)
  - ETBE
  - Ethane
  - Ethanol
  - Ethyl Benzene and Derivatives
  - Ethylene and Derivatives
  - Ethylene Dichloride and Derivatives
  - Ethylene Oxide
  - Flares / Flare Systems / Flare Gas Recovery
  - Formaldehyde and Derivatives
  - Glycols (ethylene, propylene)
  - Hexane
  - Hexanol
  - Isobutane
  - Isobutene
  - Isocyanates
  - Isopropanol
  - LNG
  - Loading / Unloading (truck or rail)
  - Methane
  - Methanol
  - Methyl Mercaptan
  - MTBE
  - NGL Fractionation
  - Paraxylene
  - Pentane
  - Phenol
  - Pilot Plant
  - Polyethylene
  - Polypropylene

- Polystyrene
  - Propane
  - Propylene
  - Propylene Oxide and Derivatives
  - Specialty Chemicals
  - Styrene-Butadiene
  - Synthesis Gas (CO, H<sub>2</sub>),
  - Tank Farm / Storage Facility / Offsite / Storage & Transfer Piping
  - Toluene
  - Utilities / Steam Plant / Cogeneration
  - Waste / Wastewater Handling, Treatment or Disposal
  - Xylene
  - Other (describe)
- ❖ Mode of Operation:
- Start-up
  - Planned Shutdown
  - Emergency Shutdown
  - Normal (check one):
    - Sampling
    - Loading / Unloading
    - Equipment Preparation / Taking Out of Service for Maintenance
    - Equipment Commissioning / Putting in Service Following Maintenance
    - Switching Equipment (e.g., pumps, filters)
    - Filling / Draining
    - Mixing / Handling Chemicals
    - Operator Performed Maintenance
    - Changing Lineups
    - Steady State Operation
    - Other (describe)
  - Upset
  - Turnaround
  - Routine Maintenance
  - Temporary
  - Other (describe)
- ❖ Point of Release (*Detail 1* and *Detail 2* options included from AFPM's Event Sharing database):
- Atmospheric Tank (fixed roof or internal/external floating roof)
    - *Process Liquids Storage, Large tank (>1320 gal/5000 L)*
      - *Release from vent, overflow, or around seal on floating roof*
      - *Sunk Floating Roof*
      - *Leak*
      - *Vacuum/collapse*
      - *Other*
    - *Process Liquids Storage, Small tank or tote (<1320 gal/5000 L)*
      - *Release from vent, overflow, or around seal on floating roof*
      - *Leak*
      - *Vacuum/collapse*
      - *Other*
    - *Chemical Injection/Utility Storage Large tank (>1320 gal/ 5000 L)*
      - *Release from vent, overflow, or around seal on floating roof*

- *Sunk Floating Roof*
  - *Leak*
  - *Vacuum/collapse*
  - *Other*
- *Chemical Injection/Utility Storage Small tank or tote (<1320 gal/ 5000 L)*
  - *Release from vent, overflow, or around seal on floating roof*
  - *Leak*
  - *Vacuum/collapse*
  - *Other*
- *Other Storage*
- *Blower / Fan*
  - *Seal Leak*
  - *Packing Leak*
  - *Flange/Gasket Leak*
    - *Gasket failed*
    - *Flange face damage*
    - *Wrong gasket*
    - *Bolts relaxed (i.e. thermal cycle)*
    - *Loose bolts*
    - *Other*
  - *Casing Leak*
  - *Threading fitting leak*
  - *Fitting thread leak*
  - *Fitting body leak*
  - *Other*
  - *Auxiliary System leak (i.e. tube oil)*
  - *Other*
- *Compressor*
  - *Centrifugal Compressor*
    - *Seal Leak*
    - *Packing Leak*
    - *Flange/Gasket Leak*
    - *Casing Leak*
    - *Threading fitting leak*
    - *Auxiliary System leak (i.e. tube oil)*
    - *Other*
  - *Reciprocating Compressor*
    - *Seal Leak*
    - *Packing Leak*
    - *Flange/Gasket Leak*
    - *Casing Leak*
    - *Threading fitting leak*
    - *Auxiliary System leak (i.e. tube oil)*
    - *Other*
  - *Other Compressor*
    - *Seal Leak*
    - *Packing Leak*
    - *Flange/Gasket Leak*
    - *Casing Leak*
    - *Threading fitting leak*
    - *Auxiliary System leak (i.e. tube oil)*
    - *Other*
- *Cooling Tower*
- *Filter / Coalesce / Strainer*
  - *Housing Leak*
  - *Head/Closure gasket leak*
    - *Gasket failed*

- *Flange face damage*
- *Wrong gasket*
- *Bolts relaxed (i.e. thermal cycle)*
- *Loose bolts*
- *Other*
- *Flange/Gasket Leak*
  - *Gasket failed*
  - *Flange face damage*
  - *Wrong gasket*
  - *Bolts relaxed (i.e. thermal cycle)*
  - *Loose bolts*
  - *Other*
- *Threading fitting leak*
  - *Fitting thread leak*
  - *Fitting body leak*
- *Other*
- *Fired Boiler*
  - *Steam/Water Tube Leak*
  - *Fuel Leak*
  - *Fire box explosion*
  - *Flange/Gasket Leak*
    - *Gasket failed*
    - *Flange face damage*
    - *Wrong gasket*
    - *Bolts relaxed (i.e. thermal cycle)*
    - *Loose bolts*
    - *Other*
  - *Threading fitting leak*
    - *Fitting thread leak*
    - *Fitting body leak*
  - *Other*
- *Flare / Relief System*
  - *Flare system leak (headers/drums/stack)*
  - *Relief valve leak*
  - *Flare liquid carry over/rainout*
  - *Atmospheric relief valve discharge*
  - *Other*
- *Furnace / Fired Heater*
  - *Process tube Leak*
  - *Steam/Water Tube Leak*
  - *Fuel Leak*
  - *Fire box explosion*
  - *Flange/Gasket Leak*
    - *Gasket failed*
    - *Flange face damage*
    - *Wrong gasket*
    - *Bolts relaxed (i.e. thermal cycle)*
    - *Loose bolts*
    - *Other*
  - *Threading fitting leak*
    - *Fitting thread leak*
    - *Fitting body leak*
  - *Other*
- *Heat Exchanger*
  - *Shell and Tube Type*
    - *Shell Leak*
    - *Tube Leak*

- *Channel Head / Tube sheet / Gasket Leak*
- *Flange / Gasket Leak*
- *Repair Clamp Leak*
- *Other*
- *Air Cooler Type*
  - *Header Box Leak*
  - *Tube leak*
  - *Flange / Gasket Leak*
  - *Exchanger Repair Clamp Leak*
  - *Other*
- *Plate and Frame*
  - *Plate/Gasket Leak*
  - *Flange/Gasket Leak*
  - *Exchanger repair clamp leak*
  - *Other*
- *Other exchanger*
  - *Shell leak – go to failure mode*
  - *Tube leak – go to failure mode*
  - *Channel head/tube sheet/ gasket leak*
  - *Flange/Gasket Leak*
  - *Repair Clamp Leak*
  - *Other*
- Instrumentation
  - *Control valve*
    - *Valve packing leak*
    - *Valve leak thru – go to failure mode*
    - *Valve left open*
    - *Valve body leak – go to failure mode*
    - *Other*
  - *Analyzer*
  - *Flow instrument*
  - *Pressure instrument*
  - *Level instrument*
  - *Temperature instrument*
  - *Other*
- Piping System, Large Bore > 50 mm (2 inch) (piping, gaskets, sight glasses, expansion joints, tubing, valves)
  - *Above Ground Piping Leak, Diameter >2" (non dead leg)*
    - *Pipe Run Leak (leak in wall of pipe)*
    - *Piping Repair clamp leak*
    - *Flange/Gasket Leak*
    - *Valve*
    - *Fitting Leak*
    - *Other*
  - *Below Ground Piping Leak, Diameter >2" (non dead leg)*
    - *Pipe Run Leak (leak in wall of pipe)*
    - *Piping Repair clamp leak*
    - *Flange/Gasket Leak*
    - *Valve*
    - *Fitting Leak*
    - *Other*
  - *Dead Leg Leak, Diameter >2" (either above or below ground)*
    - *Pipe Run Leak (leak in wall of pipe)*
    - *Piping Repair clamp leak*
    - *Flange/Gasket Leak*
    - *Valve*
    - *Fitting Leak*
    - *Other*
  - *Tubing Leak*

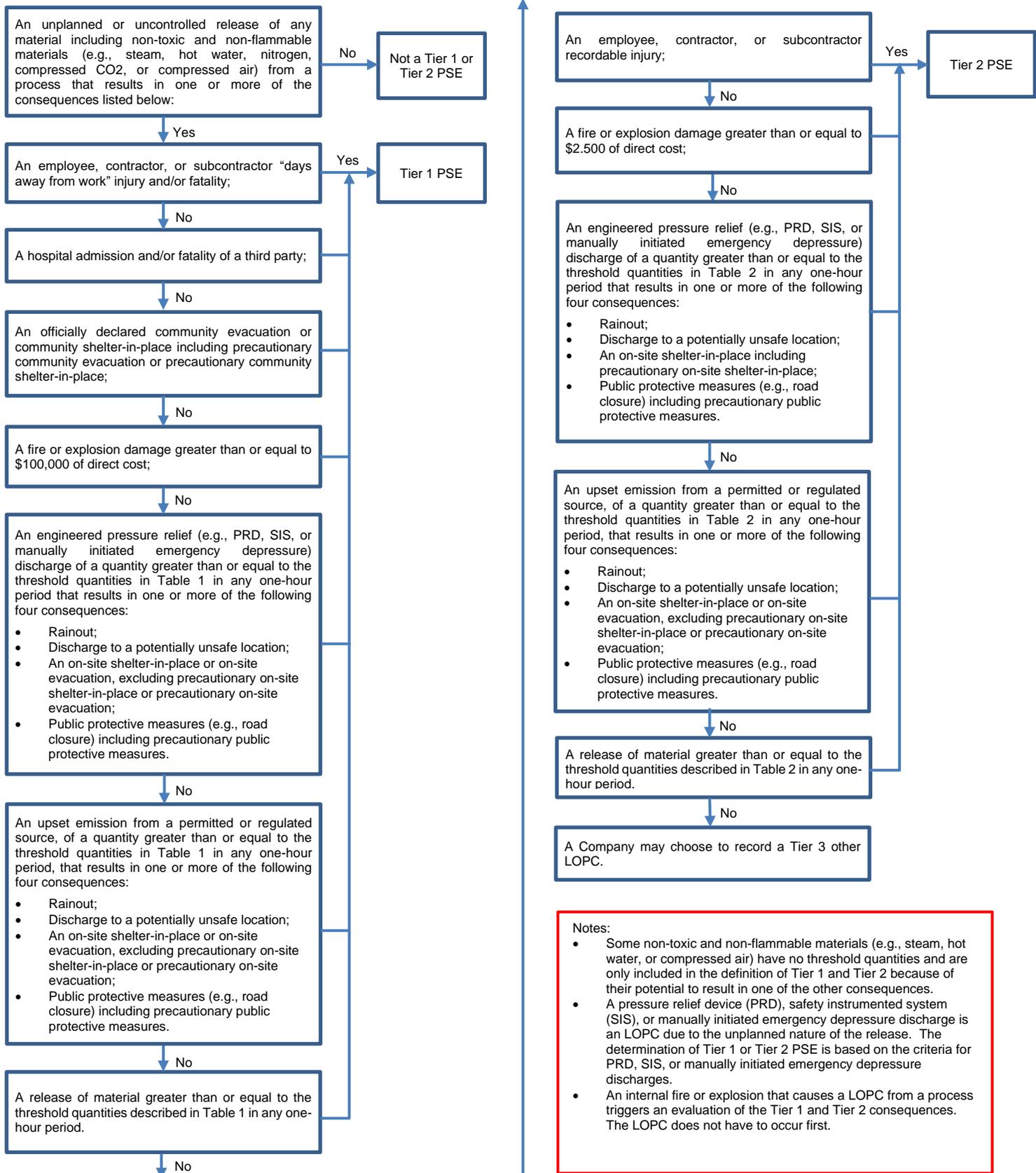
- *SS Tubing*
- *Copper Tubing*
- *Plastic/PVC Tubing*
- *Other tubing*
- *Hose Leak*
  - *Braided metal*
  - *Chemical Hose (typically plastic or polymer)*
  - *Utility Hose (typically rubber)*
  - *Other hose*
- *PVC or other non-metallic pump*
  - *Pipe Run Leak (leak in wall of pipe)*
  - *Piping Repair Clamp leak*
  - *Flange/Gasket Leak*
  - *Valve*
  - *Fitting Leak*
- Piping System, Small Bore ≤ 50 mm (2 inch) (piping, gaskets, sight glasses, expansion joints, tubing, valves)
  - *Above Ground Piping Leak, Diameter ≤2" (non dead leg)*
    - *Pipe Run Leak (leak in wall of pipe)*
    - *Piping Repair clamp leak*
    - *Flange/Gasket Leak*
    - *Valve*
    - *Fitting Leak*
    - *Other*
  - *Below Ground Piping Leak, Diameter ≤2" (non dead leg)*
    - *Pipe Run Leak (leak in wall of pipe)*
    - *Piping Repair clamp leak*
    - *Flange/Gasket Leak*
    - *Valve*
    - *Fitting Leak*
    - *Other*
  - *Dead Leg Leak, Diameter ≤2" (either above or below ground)*
    - *Pipe Run Leak (leak in wall of pipe)*
    - *Piping Repair clamp leak*
    - *Flange/Gasket Leak*
    - *Valve*
    - *Fitting Leak*
    - *Other*
  - *Tubing Leak*
    - *SS Tubing*
    - *Copper Tubing*
    - *Plastic/PVC Tubing*
    - *Other tubing*
  - *Hose Leak*
    - *Braided metal*
    - *Chemical Hose (typically plastic or polymer)*
    - *Utility Hose (typically rubber)*
    - *Other hose*
  - *PVC or other non-metallic pump*
    - *Pipe Run Leak (leak in wall of pipe)*
    - *Piping Repair Clamp leak*
    - *Flange/Gasket Leak*
    - *Valve*
    - *Fitting Leak*
- Pressure Vessel (drum, tower, pressurized storage)
  - *Tower*
    - *Wall/head leak*
    - *Flange/Gasket Leak*
    - *Threading fitting leak*

- Other
- Drum
  - Wall/head leak
  - Flange/Gasket Leak
  - Threading fitting leak
  - Other
- Pressurized Storage
  - Wall/head leak
  - Flange/Gasket Leak
  - Threading fitting leak
  - Other
- Other
  - Wall/head leak
  - Flange/Gasket Leak
  - Threading fitting leak
  - Other
- Pump
  - Process Pump
    - Seal Leak
    - Packing Leak
    - Flange/Gasket Leak
    - Casing Leak
    - Threading fitting leak
    - Auxiliary System leak (i.e. tube oil)
    - Other
  - Chemical Injection/Utility Pump
    - Seal Leak
    - Packing Leak
    - Flange/Gasket Leak
    - Casing Leak
    - Threading fitting leak
    - Auxiliary System leak (i.e. tube oil)
    - Other
  - Other Pump
    - Seal Leak
    - Packing Leak
    - Flange/Gasket Leak
    - Casing Leak
    - Threading fitting leak
    - Auxiliary System leak (i.e. tube oil)
    - Other
- Reactor
  - Wall/head leak
  - Flange/Gasket Leak
    - Gasket failed
    - Flange face damage
    - Wrong gasket
    - Bolt relaxed (i.e. thermal cycle)
    - Loose bolts
    - Other
  - Threaded Fitting Leak
    - Fitting thread leak
    - Fitting body leak
    - Other
  - Other
    - Other (describe)
- ❖ Type of Material released (check one):
  - Flammable

- Combustible
  - Toxic
  - Corrosive
  - UNDG Class 2, Division 2.2
  - Utilities (e.g. air, water, steam, nitrogen, etc.)
  - Other (describe)
- ❖ Causal Factors (check all that apply, maximum of three):
- Change Management LTA
  - Communication LTA
  - Design LTA
  - Equipment Reliability LTA
  - Fixed Equipment Inspection LTA
  - Human Factors LTA
  - Knowledge and Skills LTA
  - Operating Limits LTA
  - Procedures LTA
  - Risk Assessment LTA
  - Safe Work Practices or Procedures LTA
  - Work Monitoring LTA
  - Other (describe)

## APPENDIX C

### PSE Tier 1 / Tier 2 DETERMINATION DECISION LOGIC TREE (PER API RP 754)



## APPENDIX D

### Tier 1 PSE Severity Weighting<sup>35</sup>

Severity weighting, whether Company defined, or industry association defined, can provide additional useful information about Tier 1 PSEs that may help drive performance improvement. Table 3 is an example of a methodology for calculating a severity weight for Tier 1 PSEs that a Company may find beneficial. The severity weighting is not intended to produce an ordinal ranking of Tier 1 PSEs, but rather a relative differentiation between one Tier 1 PSE and another. There is no intended or implied equating of consequences from one category to the next. Also, there is no intended or implied value judgment that a Tier 1 PSE with a higher severity score is “worse” than another Tier 1 PSE with a lower severity score.

Using Table 3, a severity weight for each Tier 1 PSE may be calculated by summing the points associated with each consequence category.

**Table 3—Tier 1 Process Safety Event Severity Weighting**

Severity Points	Consequence Categories				
	Safety/Human Health <sup>a</sup>	Direct Cost from Fire or Explosion	Material Release Within Any 1-Hr Period <sup>a</sup>	Community Impact	Off-Site Environmental Impact <sup>b, c</sup>
1 point	<ul style="list-style-type: none"> <li>Injury requiring treatment beyond first aid to an employee, contractor, or subcontractor. (Meets the definition of a US OSHA recordable injury.)</li> </ul>	<ul style="list-style-type: none"> <li>Resulting in \$100,000 ≤ Direct Cost Damage &lt; \$1,000,000.</li> </ul>	<ul style="list-style-type: none"> <li>Release volume 1x ≤ Tier 1 TQ &lt; 3x outside of secondary containment.</li> </ul>	<ul style="list-style-type: none"> <li>Officially declared shelter-in-place or public protective measures (e.g., road closure) for &lt; 3 hours, or</li> <li>Officially declared evacuation &lt; 3 hours.</li> </ul>	<ul style="list-style-type: none"> <li>Resulting in \$100,000 ≤ Acute Environmental Cost &lt; \$1,000,000.</li> </ul>
3 points	<ul style="list-style-type: none"> <li>Days Away From Work injury to an employee, contractor, or subcontractor, or</li> <li>Injury requiring treatment beyond first aid to a third party.</li> </ul>	<ul style="list-style-type: none"> <li>Resulting in \$1,000,000 ≤ Direct Cost Damage &lt; \$10,000,000.</li> </ul>	<ul style="list-style-type: none"> <li>Release volume 3x ≤ Tier 1 TQ &lt; 9x outside of secondary containment.</li> </ul>	<ul style="list-style-type: none"> <li>Officially declared shelter-in-place or public protective measures (e.g., road closure) for &gt; 3 hours, or</li> <li>Officially declared evacuation &gt; 3 hours &lt; 24 hours.</li> </ul>	<ul style="list-style-type: none"> <li>Resulting in \$1,000,000 ≤ Acute Environmental Cost &lt; \$10,000,000, or</li> <li>Small-scale injury or death of aquatic or land-based wildlife.</li> </ul>

<sup>35</sup> API Recommended Practice 754

9 points	<ul style="list-style-type: none"> <li>• A fatality of an employee, contractor, or subcontractor, or</li> <li>• A hospital admission of a third party.</li> </ul>	<ul style="list-style-type: none"> <li>• Resulting in <math>\\$10,000,000 \leq</math> Direct Cost Damage <math>&lt;</math> <math>\\$100,000,000</math>.</li> </ul>	<ul style="list-style-type: none"> <li>• Release volume <math>9x \leq</math> Tier 1 TQ <math>&lt;</math> <math>27x</math> outside of secondary containment.</li> </ul>	<ul style="list-style-type: none"> <li>• Officially declared evacuation <math>&gt;</math> 24 hours <math>&lt;</math> 48 hours.</li> </ul>	<ul style="list-style-type: none"> <li>• Resulting in <math>\\$10,000,000 \leq</math> Acute Environmental Cost <math>&lt;</math> <math>\\$100,000,000</math>, or</li> <li>• Medium-scale injury or death of aquatic or land-based wildlife.</li> </ul>
27 points	<ul style="list-style-type: none"> <li>• Multiple fatalities of employees, contractors, or subcontractors, or</li> <li>• Multiple hospital admission of third parties, or</li> <li>• A fatality of a third party.</li> </ul>	<ul style="list-style-type: none"> <li>• Resulting in <math>\geq</math> <math>\\$100,000,000</math> of direct cost damages.</li> </ul>	<ul style="list-style-type: none"> <li>• Release volume <math>\geq 27x</math> Tier 1 TQ outside of secondary containment.</li> </ul>	<ul style="list-style-type: none"> <li>• Officially declared evacuation <math>&gt;</math> 48 hours.</li> </ul>	<ul style="list-style-type: none"> <li>• Resulting in <math>\geq</math> <math>\\$100,000,000</math> of Acute Environmental Costs, or</li> <li>• Large-scale injury or death of aquatic or land-based wildlife</li> </ul>
<p>a Where there is no secondary containment, the quantity of material released from primary containment is used. Where secondary containment is designed to only contain liquid, the quantity of the gas or vapor being released and any gas or vapor evolving from a liquid must be calculated to determine the amount released outside of secondary containment.</p> <p>b Judging small, medium, or large scale injury or death of aquatic or land-based wildlife should be based on local regulations or Company guideline</p> <p>c The severity weighting calculation includes a category for "Off-Site Environmental Impact" and injury beyond first aid (i.e., OSHA "recordable injury") level of Safety/Human Health impact which are not included in the Tier 1 PSE threshold criteria. However, the purpose of including both of these values is to achieve greater differentiation of severity points for events that result in any form of injury or environmental impact.</p>					

## APPENDIX E

### Application to Petroleum Pipeline & Terminal Operations (informative)

*RP-754 was developed for the refining and petrochemical industries, but it may also be applicable to other industries with operating systems and processes where loss of containment has the potential to cause harm, such as petroleum pipeline and terminal operations. RP-754 may be applied to petroleum pipeline and terminal operations by substituting the following sections for those used in the body of this recommended practice.*

#### 1.3 Applicability

*This recommended practice applies to the responsible party. At collocated facilities (e.g., industrial park), this recommended practice applies individually to the responsible parties and not to the facility as a whole.*

Events associated with the following activities fall outside the scope of this RP and shall not be included in data collection or reporting efforts:

- a) marine transport operations, except when the vessel is connected or in the process of connecting or disconnecting to the process;
- b) truck or rail operations, except when the truck or rail car is connected or in the process of connecting or disconnecting to the process, or when the truck or rail car is being used for on-site storage;

NOTE Active staging is not part of connecting or disconnecting to the process; active staging is not considered on-site storage; active staging is considered part of transportation.

- c) vacuum truck operations, except on-site truck loading or discharging operations, or use of the vacuum truck transfer pump;
- d) routine emissions from permitted or regulated sources;  
NOTE Upset emissions are evaluated as possible Tier 1 or Tier 2 PSEs per Section 5.2 and 6.2.
- e) office, shop and warehouse building events (e.g. office fires, spills, personnel injury or illness, etc.);
- f) personal safety events (e.g., slips, trips, falls) that are not directly associated with on-site response or exposure to a loss of primary containment (LOPC) event;
- g) LOPC events from ancillary equipment not connected to the process (e.g., small sample containers);
- h) quality assurance (QA) and quality control (QC) laboratories; and
- i) on-site fueling operations of mobile and stationary equipment (e.g., pick-up trucks, diesel generators, and heavy equipment).

## 2 Terms and Definitions

### 2.37

#### process

Distribution, storage, utilities, or loading facilities used store and transport petrochemical and petroleum refining feedstocks and products. This includes process equipment (e.g., vessels, piping, process sumps, vapor recovery systems, pumps, compressors, exchangers, pigging stations, metering stations, refrigeration systems, etc.), storage tanks, active warehouses, ancillary support areas (e.g., waste water and ballast water treatment plants), on-site remediation facilities, and on-site and off-site distribution piping under control of the Company.

## APPENDIX F

### Application to Retail Service Stations (informative)

*RP-754 was developed for the refining and petrochemical industries, but it may also be applicable to other industries with operating systems and processes where loss of containment has the potential to cause harm, such as retail service stations. RP-754 may be applied to retail service stations by substituting the following sections for those used in the body of this recommended practice. Retail service stations dispense gasoline, diesel, biofuels, propane, compressed natural gas, and hydrogen to the public.*

*This recommended practice applies to the responsible party. At collocated facilities (e.g., industrial park), this recommended practice applies individually to the responsible parties and not to the facility as a whole.*

### 1.3 Applicability

Events associated with the following activities fall outside the scope of this RP and shall not be included in data collection or reporting efforts:

- a) truck operations, except when the truck is connected or in the process of connecting or disconnecting to the process or when the truck is being used for on-site storage;

NOTE Active staging is not part of connecting or disconnecting to the process; active staging is not considered on-site storage; active staging is part of transportation.

- b) routine emissions from permitted or regulated sources;

NOTE Upset emissions are evaluated as possible Tier 1 or Tier 2 PSEs per Section 5.2 and 6.2.

- c) office, shop, and convenience store events (e.g. office fires, spills, personnel injury or illness, etc.);
- d) personal safety events (e.g., slips, trips, falls) that are not directly associated with on-site response or exposure to a loss of primary containment (LOPC) event;
- e) LOPC events from ancillary equipment not connected to the process (e.g., small sample containers); and
- f) releases caused by the actions of retail customers.

NOTE Failure of the auto shutoff, in countries where 'latch' filling is permitted, that causes a spill is not considered an action of the retail customer.

## 2 Terms and Definitions

### process

Storage and dispensing facilities used for retail sales of petroleum refining products and biofuels. This includes process equipment (e.g., LPG vessels, piping, hoses, pumps, compressors, exchangers, etc.), above or below ground storage tanks, active warehouses, dispensers, and LPG exchange cylinders under control of the Company.

## **APPENDIX G**

### **Oil & Gas Drilling and Production Operations (informative)**

*RP-754 was developed for the refining and petrochemical industries, but may also be applicable to other industries with operating systems and processes where loss of containment has the potential to cause harm such as oil and gas drilling and production activities. RP-754 may be applied to oil and gas drilling and production operations by following the guidance provided in IOGP Report No. 456.*