ANSI / API RP-754

Process Safety Performance Indicators for the Refining & Petrochemical Industries

Part 3 – Tier 3 and 4 Process Safety Indicators

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API RP-754 Drafting Committee

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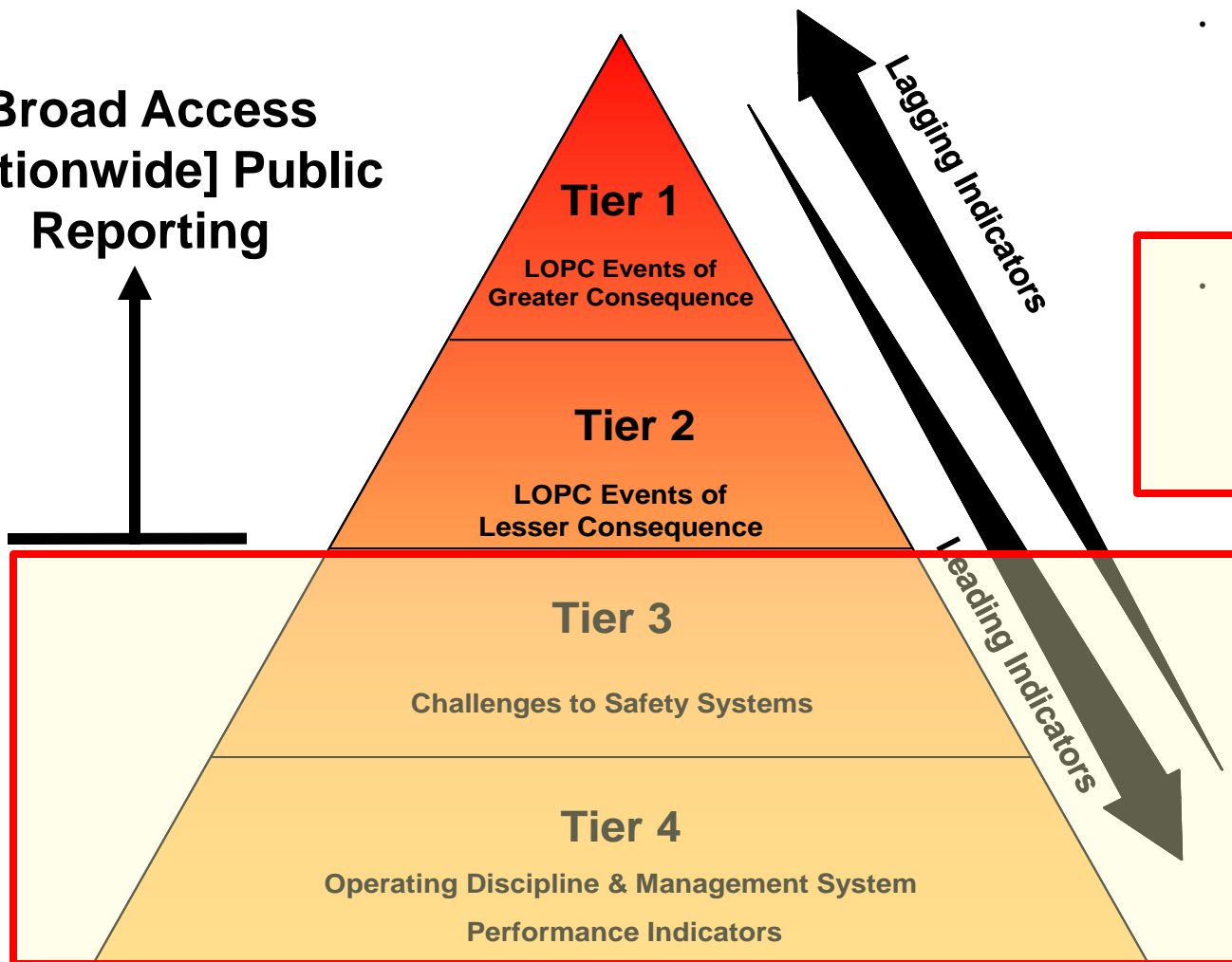
Part 3 – Tier 3 and 4 Process Safety Indicators

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- Overview of Process Safety Indicator Pyramid

- Tier 3 & 4 versus Tier 1 & 2

- Tier 3 Performance Indicators – Challenges to Safety Systems

- Tier 4 Performance Indicators – Operating Discipline & Management System Performance

- Guidelines for Selection of Process Safety Indicators

- Reporting of Performance Indicators
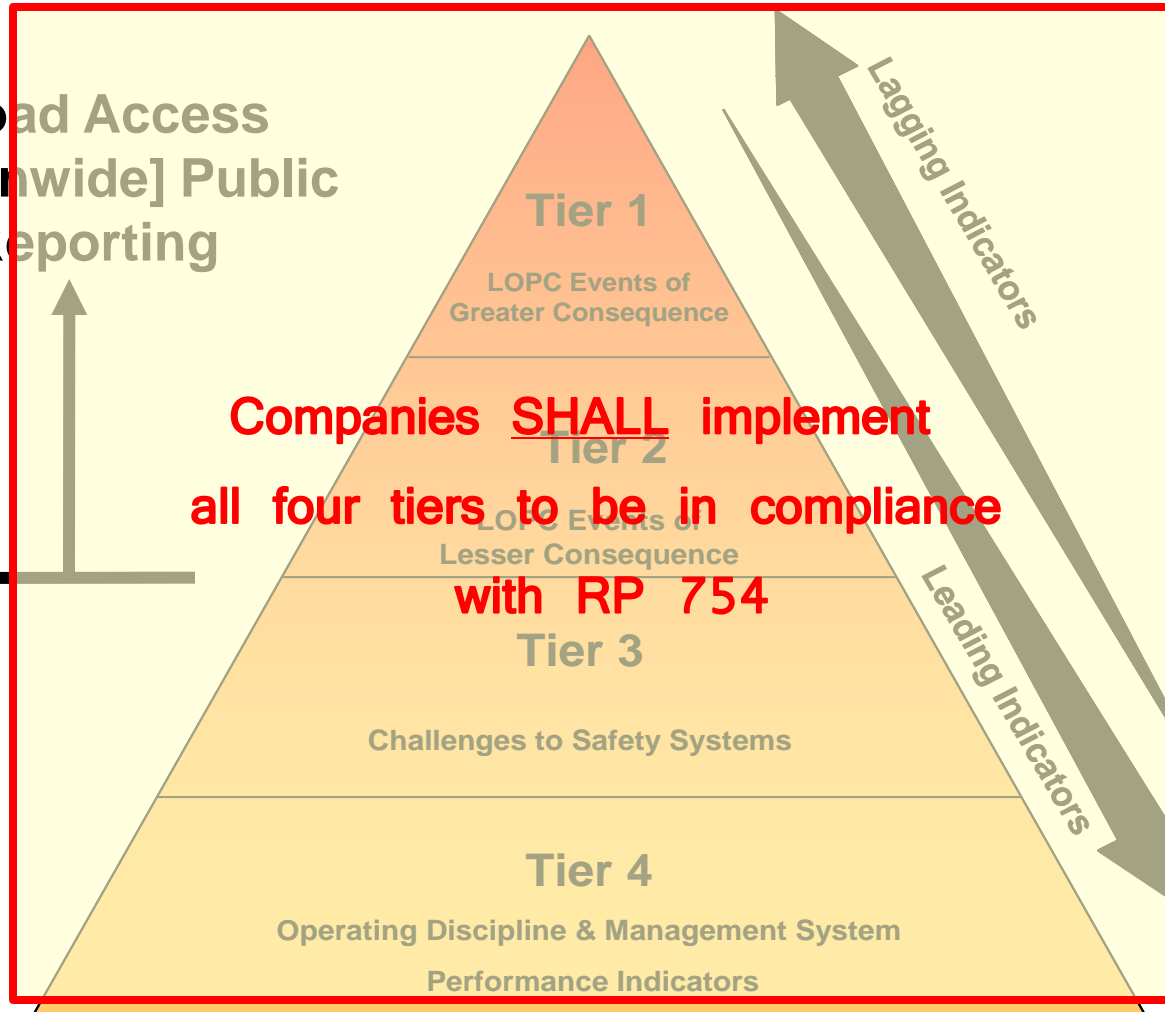
Process Safety Indicator Pyramid

Broad Access [Nationwide] Public Reporting

Tier 1
LOPC Events of Greater Consequence

Tier 2
LOPC Events of Lesser Consequence

Tier 3
Challenges to Safety Systems

Tier 4
Operating Discipline & Management System
Performance Indicators

Lagging Indicators

Leading Indicators

- Tiers 1 & 2 are RP-754 standardized definitions

- Tiers 3 & 4 are company defined performance indicators

Broad Access [Nationwide] Public Reporting

Tier 1 — LOPC Events of Greater Consequence

Tier 2 — LOPC Events of Lesser Consequence

Tier 3 — Challenges to Safety Systems

Tier 4 — Operating Discipline & Management System Performance Indicators

Lagging Indicators

Leading Indicators

Companies **SHALL** implement all four tiers to be in compliance with RP 754

- Tiers 1 & 2 are RP-754 standardized definitions

- Tiers 3 & 4 are company/site defined performance indicators

Tier 3 & 4 versus Tier 1 & 2

Swiss Cheese Model

HAZARD

Protective "Barriers"

"Weaknesses" or holes
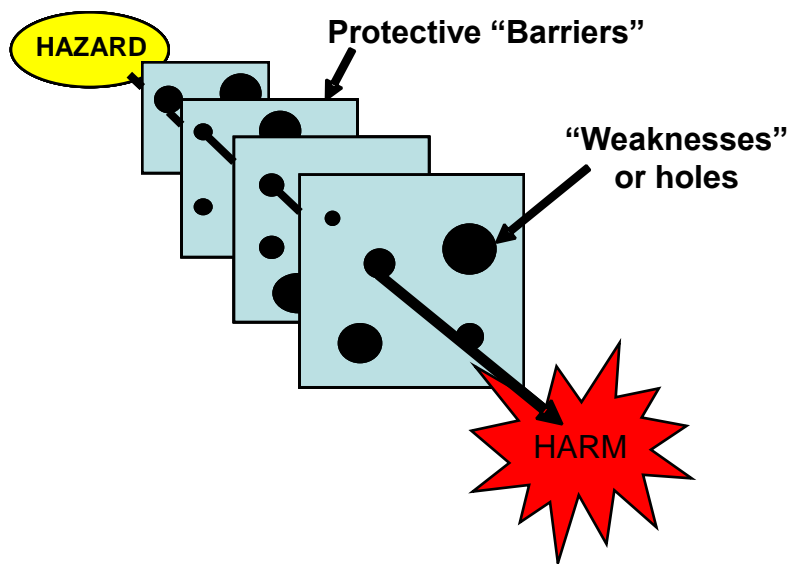
HARM

➢ The Swiss Cheese Model (Reason, 1990) helps to compare and contrast:

- Tier 1 events result in some level of harm (fire, LWC, release, etc.)

- Tier 2 events result in a lesser level of harm.

- Tier 3 and 4 indicators provide information about the strength (or lack thereof) of barriers and weaknesses in the equipment and hazard control systems.

# Tier 3: Challenges to Safety Systems

A Tier 3 indicator represents a <u>challenge to the barrier system</u> that progressed along the path to harm but stopped short of a Tier 1 or 2 loss of primary containment consequence.

- Companies **shall** develop and use Tier 3 indicators.
- Tier 3 indicators provide an additional opportunity to identify and correct weaknesses within the barrier system.
- The standard provides four Tier 3 indicators for consideration.
  - Safe Operating Limit Excursions
  - Primary Containment Inspection or Testing Results Outside Acceptable Limits
  - Demands on Safety Systems
  - Other LOPC Events
- Companies may use these four or develop their own.

Safe Operating Limit Excursions

- This is a process parameter deviation that exceeds the safe operating limit applicable to the phase of operation.

- Different operating phases (startup, ongoing operation, steps in a batch process, etc.) may have different SOL's for the same equipment.

- Safe Operating Limits represent the point beyond which troubleshooting ends and pre-determined action occurs to return the process to a known safe state.

- Pre-determined actions may range from manually executed operating procedures to a fully automated safety instrumented system.

Example of Safe Operating Limit for Tank Level
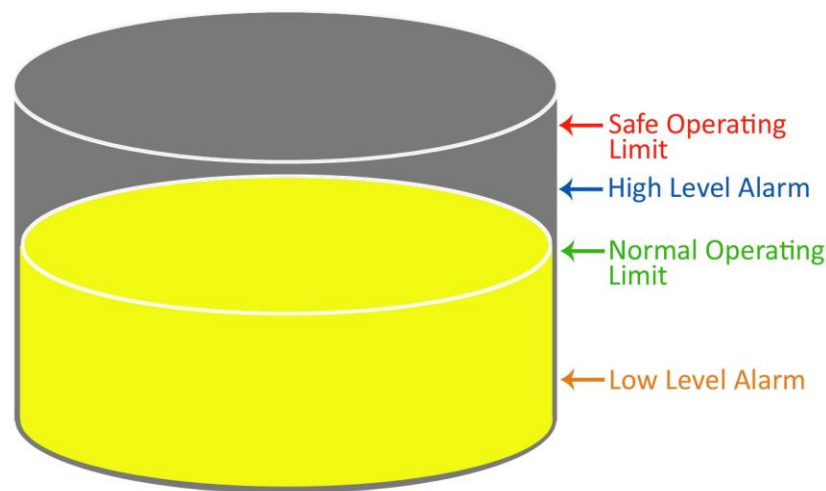
Primary Containment Inspection or Testing Results Outside Acceptable Limits

- This is an inspection or test finding that indicates primary containment equipment has been operated outside acceptable limits.

- Findings typically trigger actions such as replacement-in-kind, repairs to restore fitness-for-service, replacement with other materials, increased inspection or testing, or de-rating of process equipment.

- Counted for vessels, atmospheric storage tanks, piping or machinery when previous operating pressures or levels exceed the acceptable limits based upon wall thickness inspection measurement.

Demands on Safety Systems

- This is a demand on a safety system designed to prevent a loss of primary containment (LOPC) or to mitigate the consequences of a LOPC.

- Examples include safety instrumented systems, mechanical shutdown devices, and pressure relief devices.

- Excluded from the metric:

  - Intentional activation of the safety system during periodic testing or manual activation as part of the normal shutdown process.

  - SIS activation configured for equipment protection with no LOPC consequence.

  - Mechanical shutdown system activation for equipment protection with no LOPC consequence.

Other LOPC Events

- These are a loss of primary containment with a consequence less than Tier 2 events.

- Companies establish the appropriate thresholds meaningful to your operations and your process safety goals.

- Consequences should reflect process safety hazards rather than health (e.g. personnel exposure limits) or environmental (e.g. fugitive emissions) hazards.

Purpose of Tier 4 Indicators

A Tier 4 indicator represents your <u>Operating Discipline and Management System performance</u>.

- Companies **shall** develop and use Tier 4 performance indicators.
- Tier 4 indicators are indicative of process safety system weaknesses that may contribute to future Tier 1 or 2 events.
- The standard provides a starting point for the thought process that must take place within each Company and at each facility.
- Indicators should be the meaningful few with the highest predictive ability and provide actionable information.

Operating Discipline and Management System Indicators:

1. **Process Hazard Evaluations Completion** – Schedule of process area retrospective and revalidation hazard evaluations completed on time by fully qualified teams.

2. **Process Safety Action Item Closure** – Percentage and/or number of past-due process safety actions. This may include items from incident investigations, hazard evaluations or compliance audits.

3. **Training Completed on Schedule** -- Percentage of process safety required training sessions completed with skills verification.

4. **Procedures Current and Accurate** -- Percent of process safety required Operations and Maintenance procedures reviewed or revised as scheduled.

5. **Work Permit Compliance** -- Percent of sampled work permits that met all requirements. This may include Permit to Enter, Hot Work, General Work, lockout/tagout, etc.

Operating Discipline and Management System Indicators:

6. **Safety Critical Equipment Inspection** - Percent of inspections of safety critical equipment completed on time. This may include pressure vessels, storage tanks, piping systems, pressure relief devices, pumps, instruments, control systems, interlocks and emergency shutdown systems, mitigation systems and emergency response equipment.

7. **Safety Critical Equipment Deficiency Management** - Response to safety critical inspection findings (e.g., non-functional PRD's and SIS's). This may include proper approvals for continued safe operations, sufficient interim safeguards, and timeliness of repairs, replacement, or rerate.

8. **Management of Change (MOC) and Pre Start-up Safety Review (PSSR) Compliance -** Percent of sampled MOC's and PSSR's that met all requirements and quality standards.

9. **Completion of Emergency Response Drills** - Percentage of emergency response drills completed as scheduled.

10. **Fatigue Risk Management -** Key measures of fatigue risk management systems may include: percentage of overtime, number of open shifts, number of extended shifts, number of consecutive shifts worked, number of exceptions, etc.

# The Task Ahead – Defining Your Indicators

- **<u>Additional Sources</u>**: The RP 754 standard leverages the excellent work completed by several groups in the past. For a complete treatment of process safety indicators, these references will be useful:
  - o Center for Chemical Process Safety, Guidelines for Process Safety Metrics, American Institute of Chemical Engineers, New York, 2009
  - o UK Health and Safety Executive (HSE), "Step-By-Step Guide to Developing Process Safety Performance Indicators, HSG254," Sudbury, Suffolk, UK, 2006
  - o Hopkins, Andrew, "Thinking About Process Safety Indicators," Working Paper 53, Paper prepared for the Oil and Gas Industry Conference, Manchester, UK, 2007

- Properly defined and understood indicators can give Companies confidence that the rights things are being managed and tracked.

- Poorly selected or poorly crafted indicators can result in knowledge gaps or may result in unwarranted confidence.

Characteristics of Effective Process Safety Indicators

- **Reliable** -- Measurable using an objective or unbiased scale. To be measurable, an indicator needs to be specific and discrete.
- **Repeatable** -- Similar conditions will produce similar results and different trained personnel measuring the same event or data point will obtain the same result.
- **Consistent** -- The units and definitions are consistent across the Company. This is particularly important when indicators from one area of the company will be compared with those of another.
- **Independent of Outside Influences** -- The indicator leads to correct conclusions and is independent of pressure to achieve a specific outcome.
- **Relevant** -- Relevant to the operating discipline or management system being measured; they have a purpose and lead to actionable response when outside the desired range.
- **Comparable** -- Comparable with other similar indicators. Comparability may be over time, across a company, or across an industry.
- **Meaningful** -- Includes sufficient data to measure positive or negative change.
- **Appropriate for the Intended Audience** -- Information for senior management and public reporting usually contains aggregated or normalized data and trends, and is provided on a periodic basis (e.g., quarterly or annually). Information for employees and employee representatives is usually more detailed and is reported more frequently.
- **Timely** -- Provides information when needed based upon the purpose of the indicator and the needs of the intended audience.
- **Easy to Use** -- Indicators that are hard to measure or derive are less likely to be measured or less likely to be measured correctly.
- **Auditable** -- Indicators should be auditable to ensure they meet the above expectations.

Metrics Layers

- Companies may choose to use some indicators across the entire company or across a business unit.
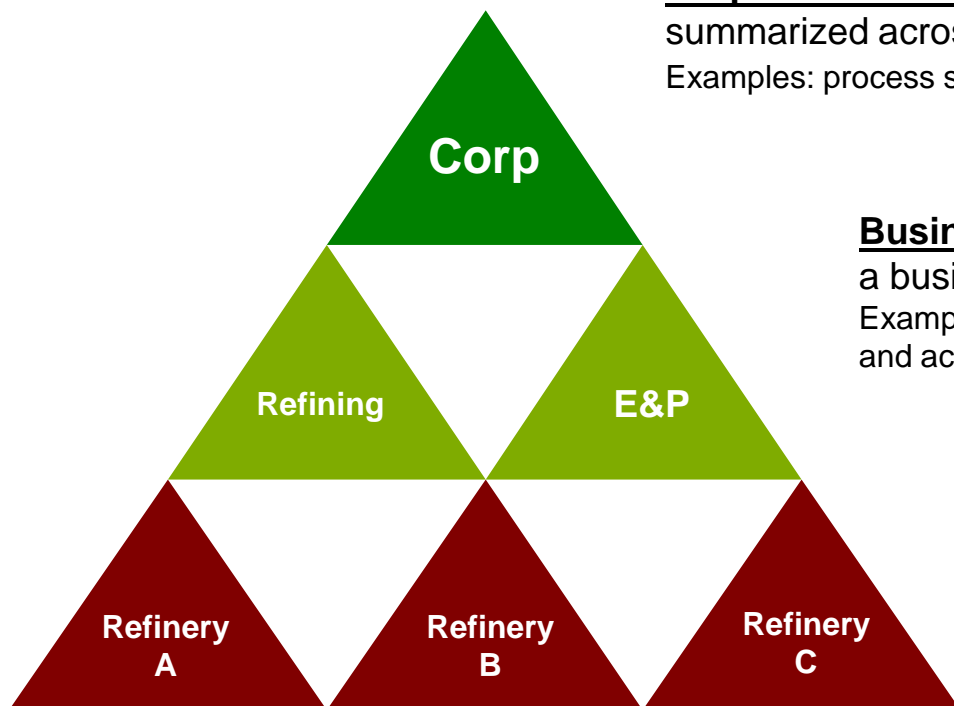
Corporate metrics: (few, common definitions, summarized across a corporation)
Examples: process safety incidents, overdue investigations

Business segment metrics: (summarized for a business unit)
Examples: action item closure, procedures current and accurate.

Operational site metrics: (collected and analyzed in detail by the site)
Examples: demands on safety systems, inspection findings, safe work practice execution, MOC compliance.

Corp

Refining

E&P

Refinery A

Refinery B

Refinery C

Selection of Indicators

- Good sources for identifying Tier 3 and 4 indicators are:
    - Process Hazards Analysis and other risk assessments
        - What can go wrong?
        - What are the consequences?
        - What is the likelihood?
        - How vulnerable are the barriers to rapid deterioration?

    - Incident Investigations

    - Shared external learnings from similar processes

    - Feedback from employees who work in and with the process

Reporting Performance Indicators

- The purpose of data collection, data analysis and reporting is to facilitate learning and improvement.

- Companies should have a philosophy of openness and transparency to satisfactorily demonstrate ongoing process safety performance.

- The format and forum for reporting data varies depending on the target audience. Audiences include:
  - Employees and employee representatives
  - Community groups and emergency management officials
  - Government agencies and the public

- Transparency and self-disclosure requires trust among those reporting and interested parties that data will be used in good faith to promote performance improvement and not for "disciplinary action" or litigation.

RP-754 Reporting Requirements – Local/Site

- Reporting to employees and employee representatives:

  - Annually, each company's site **shall** report a summary of *all four Tiers* of site-specific indicators.

  - Unattended, remote-operated or single-manned facilities are exempt from this requirement.

- Reporting to local community and emergency management officials:

  - Annually, each company's site **shall** make available a summary of site-specific Tier 1 & 2 information and can report site-specific Tier 3 & 4 along with measures taken to improve performance.

  - Reporting may occur in small group formats where details can be shared and dialog facilitated.

  - Remote sites where the worst potential-case LOPC cannot impact any public receptors are exempt from this requirement.

Timing for Tier 1 & 2 Public Reporting Requirements

- 2010 – Implementation

- 2011 – Data validation

- 2012 – Industry aggregated result

- 2013 – Industry and Company blinded results

- 2014 – Industry and Company transparent results

- Tier 2 reporting may lag Tier 1 by one year

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http://api.org/standards/psstandards

Questions