ANSI / API RP-754

Process Safety Performance Indicators for the Refining & Petrochemical Industries

Part 3 – Tier 3 and 4 Process Safety Indicators

Karen Paulk
API RP-754 Drafting Committee

Welcome and thank you for joining us for the third in a series of four webinars to discuss the content and implementation of the new ANSI/API Recommended Practice 754, Process Safety Performance Indicators for the Refining and Petrochemical Industries.

All four webinars are being recorded for future playback on the API website.

My name is Karen Paulk and I am the Refining Process Safety Manager for ConocoPhillips. It was my pleasure to serve on the RP-754 drafting committee.

Following the presentation, there will be an opportunity for questions and answers.

Let's begin.

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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

• This presentation starts with a quick review of the Process Safety Indicator Pyramid.

• Next we'll compare and contrast Tier 3 & 4 versus Tier 1 & 2.

• Then we'll discuss the purpose and detailed definitions of Tier 3 and 4 indicators.

• We'll show you where to go for additional resources to help you define your Tier 3 & 4 indicators and review the characteristics of effective indicators.

• Finally we'll cover RP-754's requirements for reporting of Process Safety Indicators.

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Process Safety Indicator Pyramid
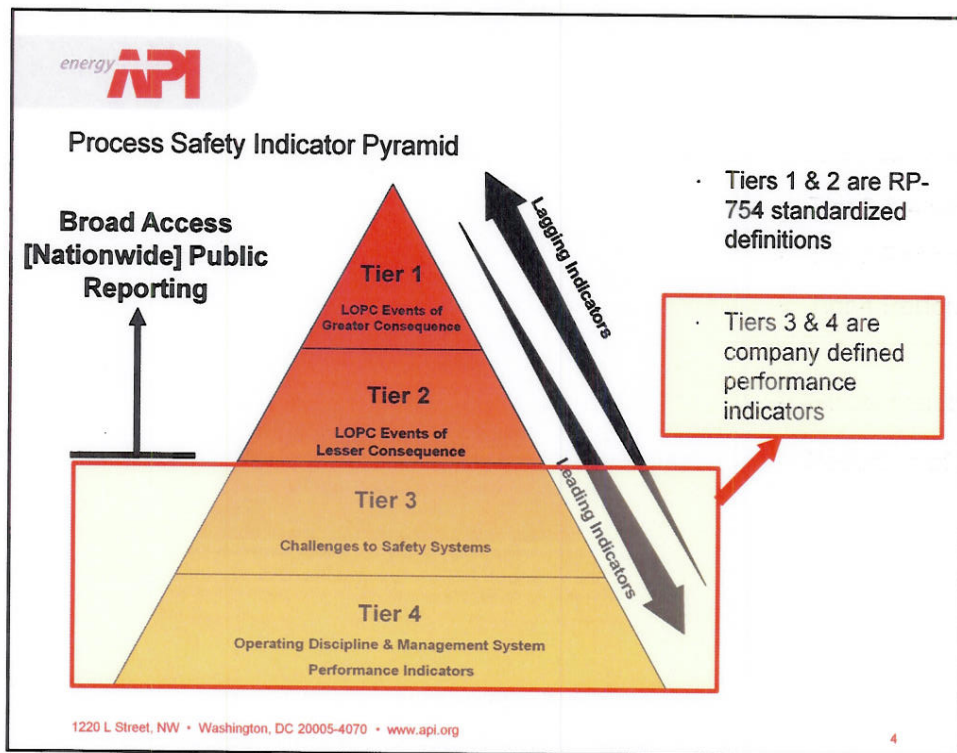
•By now you've probably seen this several times but let's review it briefly:

•The pyramid itself reflects the 1931 Heinrich model which embodies two key concepts:

•First, events can be placed on a scale of increasing consequence

•Second, precursor or predictive events occur at a lower consequence for each event with a higher consequence

•In terms of the CSB recommendation

•Tier 1 serves as a lagging indicator

•Tier 2 serves as a leading indicator (predictive of Tier 1).

•Tiers 3 & 4 serve as indicators for use at individual facilities. We will review these in detail today.

•Tier 4 and to some extent Tier 3 are the action end of the pyramid. It is at this level that performance is improved which in turn affects the outcomes measured by Tiers 1 & 2. Today we are focusing on Tier 3 and 4 indicators.

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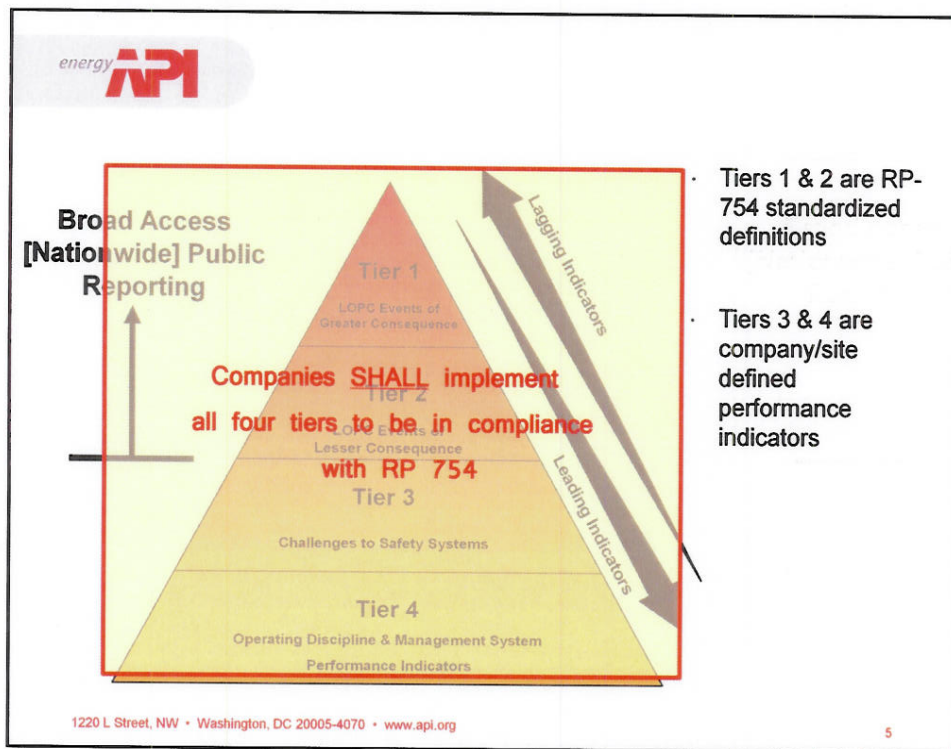
-One important item to point out is that to be in compliance with RP-754, companies must implement all four tiers.

-RP-754 provides the standardized definition for Tier 1 & 2.

-Companies must define Tier 3 & 4 indicators meaningful to their operation.

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Tier 3 & 4 versus Tier 1 & 2

Swiss Cheese Model

HAZARD — Protective "Barriers" — "Weaknesses" or holes — HARM
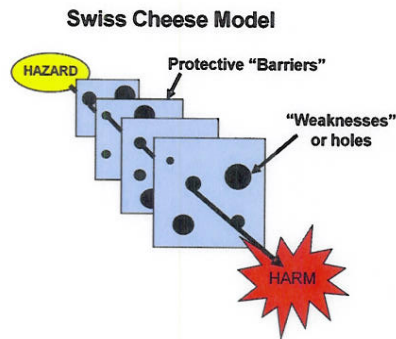
> The Swiss Cheese Model (Reason, 1990) helps to compare and contrast:
  - Tier 1 events result in some level of harm (fire, LWC, release, etc.)
  - Tier 2 events result in a lesser level of harm.
  - Tier 3 and 4 indicators provide information about the strength (or lack thereof) of barriers and weaknesses in the equipment and hazard control systems.

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• What are the basic differences between Tier 1&2 metrics (which are defined by the standard) and Tier 3&4 (which are defined by the company)?

• The Swiss Cheese Model helps us understand the differences. This model, originally proposed by British psychologist James T. Reason, illustrates that hazards (shown here in yellow) are contained by multiple protective barriers (shown here in blue). Each barrier may have weaknesses, demonstrated here as holes in the barrier. When the holes align and hazards progress through them, the hazard is released resulting in the potential for harm.

• Barriers may be physically engineered containment such as piping or vessels, or behavioral controls dependent upon people such as lock out / tag out. Holes can be latent, incipient, or actively opened by people.

• Tier 3 and 4 metrics are intended to provide meaningful information to allow the company to strengthen the barriers and eliminate the weaknesses in the hazard control system in order to prevent a Tier 1 or 2 outcome.

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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.

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•Let's discuss Tier 3 metrics first.…[Read from slide]

•Now let's look more closely at these **four** Tier 3 indicators presented in the standard.

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Tier 3 Example Indicator #1

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

Safe Operating Limit
High Level Alarm
Normal Operating Limit
Low Level Alarm
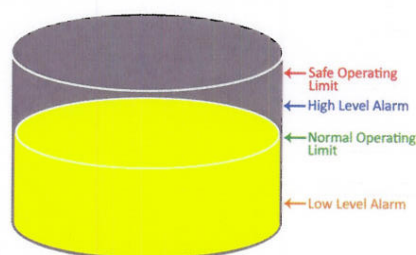
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•The first is Safe Operating Limit Excursions. ….[Read from slide]

•Shown here is an example of a Safe Operating Limit for Tank Level.

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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.

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•The second Tier 3 indicator is Primary Containment Inspection or Testing Results Outside Acceptable Limits....[Read from slide]

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Tier 3 Example Indicator #3

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.

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•The third is Demands on Safety Systems …[Read from slide]

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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.

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•The fourth is Other Loss of Primary Containment events….[Read from slide]

•RP-754 provides additional guidance on data capture for all four Tier 3 indicators.

•The RP-754 committee felt these four indicators have broad application in the processing industry and should be strongly considered by companies. However, what is **most** critical is to identify those measures that reflect the inherent risks of your particular process.

•Now let's discuss Tier 4 indicators.

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Purpose of Tier 4 Indicators

A Tier 4 indicator represents your Operating Discipline and Management System performance.

- 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.

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• …[Read from slide]

• The standard lists 10 operating discipline and management system performance indicators for your consideration. Let's review them.

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Tier 4 Example Indicators

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.

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• You will notice that most of these ten indicators not only include a measure of completion but also have an element of quality control. The ten include…[Read from slide]

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Tier 4 Example Indicators, cont'd

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.

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•[Read from slide.]

•While these 10 have broad application, the hard work that must be conducted by each site and each company is to select the ones most meaningful to your operations. So where should you start?

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The Task Ahead – Defining Your Indicators

- **Additional Sources**: 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.

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•Start with exploring additional information related to process safety indicators….[Read from slide.]

•There are some common characteristics of effective indicators. Let's look at these characteristics.

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• Take the time to review this list of characteristics later. Suffice it to say a comprehensive metrics program requires the time and talents of many personnel in your organization to define, collect, report, analyze and respond to them. It is important to spend the appropriate time up front to select and implement effective indicators.
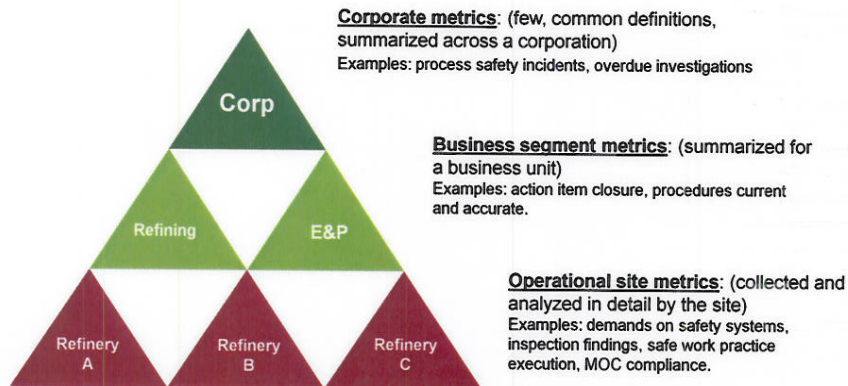
•As the last bullet point highlights, you should periodically audit your program and make changes as necessary. Sometime indicators outlive their usefulness.

•It should be noted that large companies will likely have layers of metrics as the next slide demonstrates.

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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

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•Metrics for use at the corporate level must have common definitions and be relatively few. Business Unit metrics represent the performance of a particular segment of the business. And site metrics are specific to the operational hazards for that site and those specific processes.

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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

Excellent sources for Tier 3 and 4 indicators include PHA's and other risk assessments. They can tell you…[Read from slide]

Other good sources include incident investigations – both internal and external, and feedback from employees who work in and with the process.

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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.

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•RP-754 requires reporting of process safety indicators to various stakeholders.

•[Read from slide]

•Let's look at the specific RP-754 reporting requirements for both nationwide and local/site reporting.

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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.

•At the local/site level, reporting requirements differ depending on the audience. The two primary audiences are employees and their representatives and local community and emergency management officials.

•The first, employees and employee representatives requires that…[Read from slide]

•The second, local community and emergency management officials requires that…[Read from slide]

•TRANSITION TO NEXT SLIDE.

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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•To ensure the success of transparent nationwide public reporting the following timeline is outlined to allow confirmation of data validity for the purposes of trending and comparison.

•In 2010, companies will begin implementing the requirements of RP-754.

•2011 data will provide the initial full year data validation opportunity.

•2012 data is expected to yield an industry aggregated result.

•2013 data will yield both industry and company blinded results.

•2014 data will yield transparent results.

•It is expected that Tier 2 data will lag by one year since there has been some level of equivalent Tier 1 data collection prior to RP-754.

Contact Information

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Electronic Download of RP-754

http://api.org/standards/psstandards

As I said at the beginning, all four webinars are being recorded for future playback on the API website.

If you have any questions or comments beyond today's webinar, Karen Haase is the API Staff member for RP-754. Her contact information is shown on the screen.

Also, RP-754 is available for free electronic download at the URL shown.

Okay, let's open it up for questions.

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Questions