



Global Process Safety Metrics Driving Consistency and Improvement



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Process Safety Metrics

- Can you answer the following question?
- How does your company's process safety performance compare to others?
 - Which companies are becoming safer?
 - Is your company headed for a major accident?
 - Is the chemical industry improving its process safety performance?

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Industry Call to Action



Baker Panel Report

RECOMMENDATION #7 – LEADING AND LAGGING PERFORMANCE INDICATORS FOR PROCESS SAFETY

BP should develop, implement, maintain, and periodically update an integrated set of leading and lagging performance indicators for more effectively monitoring the process safety performance of the U.S. refineries by BP's refining line management, executive management (including the Group Chief Executive), and Board of Directors. In addition, BP should work with the U.S. Chemical Safety and Hazard Investigation Board and with industry, labor organizations, other governmental agencies, and other organizations to develop a consensus set of leading and lagging indicators for process safety performance for use in the refining and chemical processing industries.



CSB Report

13.0 RECOMMENDATIONS

{American Petroleum Institute (API) and United Steelworkers International Union (USW).}

a. ...create performance indicators for process safety in the refinery and petrochemical industries. Ensure that the standard identifies leading and lagging indicators for nationwide public reporting as well as indicators for use at individual facilities. Include methods for the development and use of the performance indicators.

In the development of each standard, ensure that the committees

b. include representation of diverse sectors such as industry, labor, government, public interest and environmental organizations and experts from relevant scientific organizations and disciplines.

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Process Safety Metrics



Several companies and some trade organizations have established process safety metrics programs, but their programs:

- Differ from organization to organization
- Are likely based upon incident definitions that are not well aligned to the actual hazard of the event

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CCPS Process Safety Metric Project

- Initiated in 2006
- “Breakthrough” opportunity would be to develop a common industry lagging metric
- Many stakeholders invited to participate:
 - companies in North America, Europe, India, and Brazil,
 - ACC, American Petroleum Institute (API), National Petrochemical and Refiners Association (NPRA), European Process Safety Centre (EPSC), CONCAWE
 - US OSHA, EPA, CCCHD, Chemical Safety Board (CSB), Health Safety Executive (HSE) of UK
 - United Steelworkers (USW)
 - Wharton Business School, Texas A&M Safety Center, Members/staff of the Baker Panel

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CCPS PS Metrics Project

- Deliverables in December 2007
 - Common Industry-Wide Lagging Metric
 - Near-Miss or Other Lagging Metrics
 - Leading Metrics
 - Pamphlet with Recommendations in these three areas **COMPLETE!**

<http://www.aiche.org/ccps/metrics/index.aspx>



NEW

- Guideline Book - by EOY 2008

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Recommended Common Lagging Process Safety Metric #1

Count of Process Safety Incidents (PSI)

Criteria:

- Any releases of material or energy from a process unit resulting in:
 - Employee/contractor lost time injury(s), or
 - Fire or Explosion resulting in \$25,000 of direct cost to the company, or
 - Chemical release from the primary containment (i.e., vessel or pipe)*, greater than chemical release threshold quantities, linked to global UNDG criteria

* Excluding releases to designed control device specifically designed for that event (e.g., flare, scrubber, or PSV designed per API 521 or equivalent)

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Thresholds

Material Hazard classification as defined by United Nations Dangerous Goods definitions:

	<u>"Process Safety incident TQ"</u>
All TIH Class A materials	5 kg (11 lbs.)
All TIH Class B materials	25 kg (55 lbs.)
All TIH Class C materials	100 kg (220 lbs.)
All TIH Class D materials	200 kg (440 lbs.)
"Packing Group I" materials & "Flammable Gas"	500 kg (1100 lbs.)
"Packing Group II" materials & "Flammable Liquid"	1000 kg (2200 lbs.)
"Packing Group III" materials & "Combustible Liquid" & Division 2.2 - Nonflammable, Nontoxic Gases	2000 kg (4400 lbs.)

Note: Flexibility to use either the NFPA-30, UN Dangerous Goods, or GHS definitions for "flammable gas", "flammable liquid", or "combustible liquid". The results will be very similar, but one method may be easier to implement initially. The expectation is that companies will migrate to the GHS definitions over time.

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Example of new TQs

Substance	Threshold Quantities (lbs.) based upon:			Change vs. CERCLA
	Current API/ACC TQs: EPA CERCLA TQ (or 5000 lb. flammable)	UN Dangerous Goods hazard categories	UN Dangerous Goods hazard categories	
	total release amount	total release amount	total release amount	
n-Pentane	5000	2200	-	-
Petroleum distillates (naphtha)	5000	2200	-	-
Phenol	1000	2200	+	+
Phosgene	10	11	unch	unch
Propane	5000	1100	-	-
Propylene oxide	100	1100	+	+
Styrene	5000	4400	-	-
Sulfur dioxide	500	220	-	-
Toluene	5000	2200	-	-
Toluene 2,4-diisocyanate	100	2200	+	+
Gasoline	5000	2200	-	-
Naptha	5000	2200	-	-
Hydrogen fluoride, anhydrous	100	220	+	+
Decrease				27
Increase				13
Unchanged				3

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Key differences vs. previous ACC/API metrics

- Lower threshold for fire, explosion, and several chemical types
 - Result in higher number of reported events to sufficiently measure statistical shifts in performance
- Chemical release threshold quantities based on global severity classification (UNDG), not on US-based remediation priority (CERCLA listing)
 - EPA CERCLA: <1000 chemicals, very specific list (i.e., chemicals with similar properties not included, other than "flammables")
 - UNDG: >1800 specific chemicals and >450 generic classes of chemicals ('n.o.s.' = 'not otherwise specified') e.g., "Pyrophoric liquids, organic, n.o.s."

Resulting in many more chemicals covered.

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Proposed Common Lagging Metric #2

Process Safety Incident Rate (PSR)

- Count of incidents per man-hour
- Include both employee and contractor man-hours

$$\frac{\text{Total count of all PS incidents} \times 200,000}{\text{Total employee \& contractor work hours}}$$

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Proposed Common Lagging Metric #3

Process Safety Severity Rate (PSSR)

- The cumulative severity-weighted rate of process safety incidents per the formula described within this document.
- Assign score of 1, 3, 9, or 27 points in each category per following slide. Maximum score 108
- Sum the scores of each incident
- Divide by the same man-hour unit as PSR

$$\frac{\text{Total severity score for all PS incidents} \times 200,000}{\text{Total employee \& contractor work hours}}$$

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 Table 2: Process Safety Incidents & Severity Categories				
Severity Level (Note 4)	Safety/Human Health (Note 5)	Fire or Explosion (including overpressure)	Potential chemical impact (Note 3)	Community/environment impact (Note 5)
NA	Does not meet or exceed Level 4 threshold	Does not meet or exceed Level 4 threshold	Does not meet or exceed Level 4 threshold	Does not meet or exceed Level 4 threshold
4 (1 point used in severity rate calculations for each of the attributes which apply to the incident)	Injury requiring treatment beyond first aid to employee or contractors associated with a process safety incident (In USA, incidents meeting the definitions of an OSHA recordable injury)	Resulting in \$25,000 to \$100,000 of direct cost	Chemical released within secondary containment or contained within the unit - see Note 2A	Short-term remediation to address acute environmental impact. No long term cost or company oversight. Examples would include spill cleanup, soil and vegetation removal.
3 (3 points used in severity rate calculations for each of the attributes which apply to the incident)	Lost time injury to employee or contractors associated with a process safety event	Resulting in \$100,000 to \$1MM of direct cost .	Chemical release outside of containment but retained on company property OR flammable release without potential for vapor cloud explosives - see Note 2B	Minor off-site impact with precautionary shelter-in-place OR Environmental remediation required with cost less than \$1MM. No other regulatory oversight required. OR Local media coverage
2 (9 points used in severity rate calculations for each of the attributes which apply to the incident)	On-site fatality - employee or contractors associated with a process safety event; multiple lost time injuries or one or more serious offsite injuries associated with a process safety event.	Resulting in \$1MM to \$10MM of direct cost .	Chemical release with potential for injury off site or flammable release resulting in a vapor cloud entering a building or potential explosion site (congested/confined area) with potential for damage or casualties if ignited - see Note 2C	Shelter-in-place or community evacuation OR Environmental remediation required and cost in between \$1MM - 2.5 MM. State government investigation and oversight of process. OR Regional media coverage or brief national media coverage.
1 (27 points used in severity rate calculations for each of the attributes which apply to the incident)	Off-site fatality or multiple on-site fatalities associated with a process safety event.	Resulting in direct cost >\$10MM	Chemical release with potential for significant on-site or off-site injuries or fatalities - see Note 2D	National media coverage over multiple days OR Environmental remediation required and cost in excess of \$2.5 MM. Federal government investigation and oversight of process. OR Other significant community impact



Recommendations – Lagging Metrics

- CCPS recommends that all companies and trade associations collect and report the three lagging metrics
- While the metrics may not be perfect, CCPS recommends that they be used for 2-3 years to establish a base of experience before improvements are considered

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Proposed Leading Indicator Categories

- Mechanical Integrity
 - Inspections done / Inspections due
 - Time safety critical equipment in failed state/total operating time
- Action Items Follow-up
 - # of past due action items/total action items
- Management of Change
 - % MOC's satisfying MOC policy
- Operator Competency
 - % operators trained on schedule
- Safety Culture
 - By survey (to be defined)
- Challenges to the Safety System
 - Activations of safety systems and relief valves
 - Deviations outside of operating limits

* Metrics shown are examples. Full list in document.

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Strong industry support

- **ACC Board likely to give final approval in June.**
- **API Started using new definitions on 1/1/08**
- Indications of likely support from NPRA, SOCMA, European Process Safety Centre, and Contra Costa County CAER organization.
- International companies (e.g., SASOL) already planning to implement. Numerous other groups and companies showing interest

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What Next?



Although we've received strong indications of support, several companies and trade groups are "testing the waters"



We want them to "dive in" and implement the new metrics immediately

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Questions?

Metrics document available at:
www.aiche.org/ccps/metrics/index.aspx

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Team Members

Organization

3M
ABS Consulting
ACC
Acutech
Air Products
Albemarle
API
Bayer Material Science
BP
Braskem
CCPS
Chevron Phillips Chem.
CONCAWE
Contra Costa CHD
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DuPont
Eli Lilly
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Honeywell Specialty Mat.
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Organization

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JLM Consulting
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Lyondell
MKOCPS
Monsanto
Nova
NPRA
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PPG Industries
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