



Global Process Safety Metrics Driving Consistency and Improvement



AIChE Chicago Regional Meeting
September 22, 2008



Process Safety Metrics

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



Process Safety Metrics

- Several companies and some trade organizations have process safety metrics programs, but these programs:
 - Differ from organization to organization
 - Are likely based upon incident definitions that are not well aligned to the actual hazard of the event



Process Safety Metric Project

- Project conceived by CCPS Advisory Board
- Goal: Develop commonly acceptable lagging and leading process safety metrics that:
 - Drive improvement
 - Provide meaningful trend data
 - Establish common format to enable comparison and amalgamation
- Strive for broad stakeholder buy-in



Stakeholders Represented

- CCPS member companies in North America, Europe, India, and Brazil
- American Chemistry Council (ACC), American Petroleum Institute (API), National Petrochemical and Refiners Association (NPRA)
- US OSHA, EPA, CCCHD and Chemical Safety Board
- A chemical operator's labor union (USW)
- European Process Safety Centre (EPSC)
- CONCAWE (European HSE organization)
- Health Safety Executive of UK
- Wharton Business School, Texas A&M Safety Center
- Members/staff of the Baker Panel



Problems with Existing Metrics

- High threshold for fire and explosion
- Chemical release threshold quantities based on remediation priority (e.g., EPA CERCLA RQs), not accident severity
 - TQ for some chemicals too low, e.g., 10 lb. chloroform
 - TQ for some too high, e.g., 5000 lbs for HCL or flammables
- Although some common approaches within trade groups for lagging metrics, no common leading and near-miss metrics exist
- Low number of reported events – unless the company is very large, results in insufficient events to measure statistically shifts in performance.



CCPS PS Metrics Project

- Three Key Deliverables (for 2007)
 - Common Industry-Wide Lagging Metric
 - Near-Miss or Other Lagging Metrics
 - Draft of Leading Metrics

- Format

- Pamphlet with Recommendations in the three areas mentioned above (Leading metrics, Lagging Metrics, Near Miss reporting) - **COMPLETE!**

www.aiche.org/ccps/metrics/index.aspx

- Guideline Book - by EOY 2008



NEW



Recommended Common Lagging Process Safety Metric #1

Count of Process Safety Incidents (PSI)

- Any releases of material or energy from a process unit resulting in:
 - Employee lost time injury(s), or
 - Fire or Explosion resulting in \$25,000 US of direct cost to the company, or
 - Chemical release from the primary containment (i.e., vessel or pipe), greater than chemical release threshold quantities per next slide
 - Excluding releases to designed control device specifically designed for that event (e.g., flare, scrubber, or PSV designed per API 521 or equivalent),



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.



Example of new TQs

A few examples:	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	
Substance	total release amount	total release amount	total release amount	
<u>Acetaldehyde</u>	5000	1100	-	
<u>Acetone</u>	5000	2200	-	
<u>Acrolein</u>	1	11	+	
<u>Acrylonitrile</u>	100	1100	+	
<u>Ammonia</u>	100	440	+	
<u>Arsine</u>	100	11	-	
<u>1,3-Butadiene</u>	5000	1100	-	
<u>Carbon monoxide</u>	5000	440	-	
<u>Carbon tetrachloride</u>	Not Covered	2200	-	
<u>Chlorine</u>	10	55	+	
<u>Chloroform</u>	10	4400	+	
<u>Chloropicrin</u>	Not Covered	55	-	
<u>Cyclohexane</u>	5000	2200	-	
<u>Cyclohexene</u>	5000	2200	-	
<u>Epichlorohydrin</u>	100	2200	+	
<u>Ethanolamine</u>	Not Covered	4400	-	
<u>Ethyl alcohol</u>	5000	2200	-	
<u>Ethylamine</u>	5000	1100	-	
<u>Ethyl chloride</u>	5000	1100	-	



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Substance	total release amount	total release amount	total release amount	
<u>Ethylene oxide</u>	10	440		+
<u>Formaldehyde</u>	100	4400		+
<u>n-Hexane</u>	5000	2200		-
<u>Hydrogen chloride</u>	5000	220		-
<u>Hydrogen sulfide</u>	100	55		-
<u>L.P.G.</u>	5000	1100		-
<u>Methyl alcohol</u>	5000	2200		-
<u>Methyl chloride</u>	5000	1100		-
<u>Methyl isocyanate</u>	10	11		unch
<u>Methyl mercaptan</u>	100	220		+
<u>Nitrogen dioxide</u>	10	11		unch
<u>n-Pentane</u>	5000	2200		-
<u>Petroleum distillates (naphtha)</u>	5000	2200		-
<u>Phenol</u>	1000	2200		+
<u>Phosgene</u>	10	11		unch
<u>Propane</u>	5000	1100		-
<u>Propylene oxide</u>	100	1100		+
<u>Styrene</u>	5000	4400		-
<u>Sulfur dioxide</u>	500	220		-
<u>Toluene</u>	5000	2200		-
<u>Toluene 2,4-diisocyanate</u>	100	2200		+
<u>Gasoline</u>	5000	2200		-
<u>Naptha</u>	5000	2200		-
<u>Hydrogen fluoride, anhydrous</u>	100	220		+
		Decrease	27	
		Increase	13	
		Unchanged	3	



Recommended Common Lagging Metric #2

Process Safety Incident Rate (PSR)

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

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



Recommended 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

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

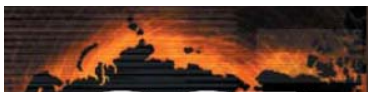


Table 2: Process Safety Incidents & Severity Categories

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



Example: HCl Release from High Pressure Line

- Estimated spilled amount = 4000 lbs, 500 lbs vapor released by flash calculation
- Three inhalation injuries, multiple day hospitalization
- Cloud appeared to travel over adjacent plant, but no measurable ground level exposure
- But adjacent plant sheltered-in-place as precaution, and adjacent interstate closed for 2 hours, resulting in national media coverage



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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



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



Proposed Leading Indicator Categories

- 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



Strong industry support

“Process safety is a key focus area for the **American Chemistry Council** and its members,” said Jack N. Gerard, President and CEO of ACC. “We’ve been voluntarily tracking and publicly reporting process safety performance of our companies for many years now under the Responsible Care program. CCPS should be commended for its work in producing this valuable tool, which will allow all of industry to better track, benchmark and report on process safety performance. **ACC will assure that its process safety measure is aligned with this cross-industry approach to measuring process safety.**”

API President and CEO Red Cavaney, whose organization has published an annual report on process safety related incidents since 1999, said “keeping employees, contractors and neighbors safe has always been a top priority for the oil and natural gas industry. **We are optimistic that the broad industry alignment on the lagging metrics developed by CCPS will lead to even greater progress in our efforts to minimize the risks to our workers and surrounding communities.**”

NPRA President Charles T. Drevna **praised the industry’s cooperation in developing an aligned process safety lagging metric.** “Process safety is a top priority for NPRA members,” Drevna said. “We appreciate the opportunity to work with CCPS on such an important issue. **This metric provides industry with a reliable benchmark in our effort to achieve even greater safety performance and will be incorporated into the NPRA Safety Awards Program.**”

“**EPSC** regards the work of the CCPS Metrics group as a global milestone in managing process safety performance for the major hazard industries”, said Manager Lee Allford

Indications of likely support from SOCMA, CEFIC, and Contra Costa County CAER organization.

International companies (e.g., SASOL) already planning to implement Numerous other groups and companies showing interest



What Next?



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



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



Please "test drive" the new metrics, and we look forward for your feedback



Future Actions

- Working with ACC, API, NPRA, SOCMA and global organizations (e.g. CCPA, ABIQUIM) to align metric programs
- Refine guidance to address the many “special situations”
- Complete CCPS Guideline Book



Thank You!

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

For more information:
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