Process Safety Knowledge Management ?

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P2SAC
Purdue Process Safety & Assurance Center

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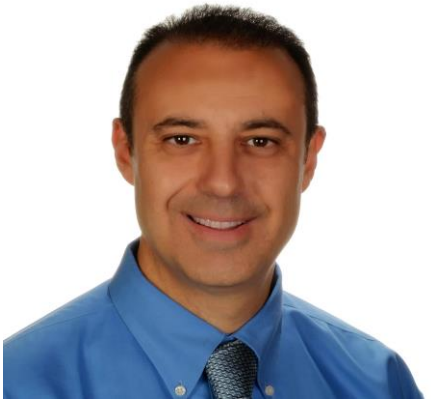

- PSRG Director, EMEA
- Based in Houston, Texas
- 26 years industry experience; last 6 years in Process Safety
- Ph.D., Chemical Engineering – University of Maryland @ College Park
- Passionate Contract Bridge Player

About PSRG

- Established in 1997 in Houston, TX (25+ years)
- Global Process Safety, Risk Management & Plant Reliability consulting and training firm
- More than 100 technical professionals averaging 29+ yrs experience
- Diverse industry experience with more than 1000 customers in 90 countries
- Tailored solutions to meet and exceed client expectations
- Member of AIChE CCPS, IChemE PSC, P2SAC and VPPPA

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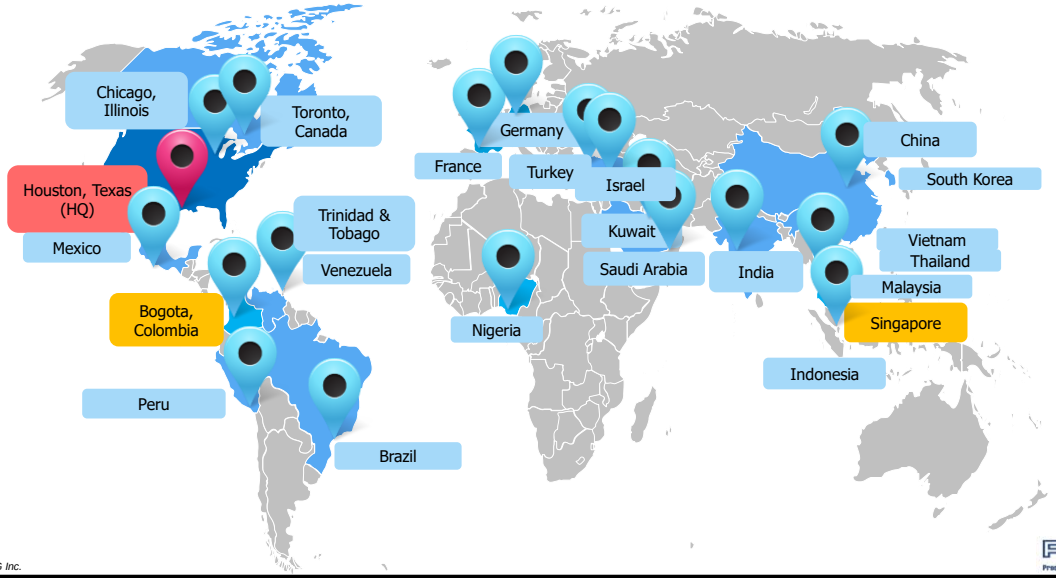
PSRG – Global Reach



PSRG API/Pharma Experience

Company	Study	Location
Abbvie	Conduct HAZOP Study (Procedure)	Singapore
Amgen	HAZOP / cHAZOP Study / PSM Audits	Singapore / Puerto Rico
Aventis Pharma	Provide Bowtie Training	Singapore
DSM	PSM/RMP Compliance Audit	USA
GSK Biologicals	PHA-HAZOP Leader Training / BowtieXP Licenses / EAC Assessment	Singapore
Johnson & Johnson/Ethicon	Boilers PHA Study - San Angelo	USA
LanzaTech	PHA Studies	USA
Merck	Conducted DHA training	China
Pfizer	PHA Study for API Plant in Michigan	USA
Zoetis	PHA Study / Audit Pilot Plant	Australia / India

Agenda

- What is Process Safety Knowledge Management (PSKM)?
- Why do we need PSKM?
  - Learning from Experience / Institutional Memory
  - Business Continuity / Sustainability / Agility
- How can we develop, implement and maintain a successful PSKM Program?
  - Logic Models for PSKM System Development / Tools
- Case Studies
  - PSKM Focus Chart

Safety Moment

Natural Gas Distribution System Explosions and Fires in Merrimack Valley, MA in Sept 2018 killed one, injured about 25 other people destroying more than 100 buildings

A home in Lawrence that was destroyed in the September explosions. *David L. Ryan / The Boston Globe*

"It's amazing to me that a company that operated this system for more than 100 years could not produce a map, a readily made map, to firefighters to show them the extent of the system and their emergency planning did not have information on valves as to how to shut the system down."

Robert Hall, National Transportation Safety Board

What is Process Safety Knowledge Management (PSKM)?

Definitions and Examples

"A society grows great when old people plant trees whose shade they know they shall never sit in."
Greek Proverb

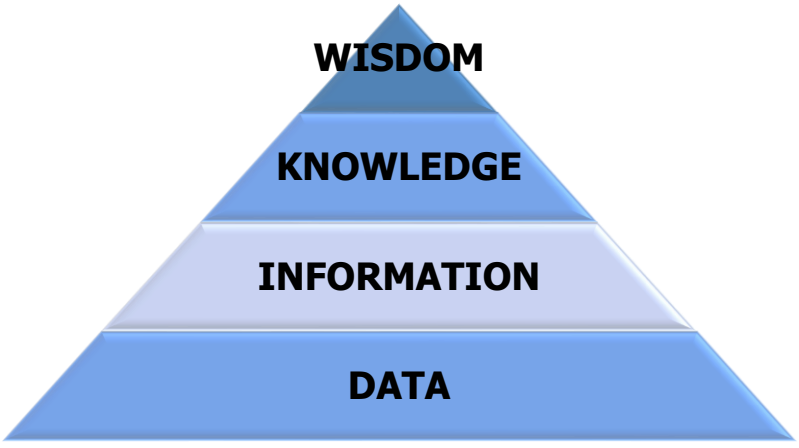
PSKM – Definition

- Subset of Knowledge Management (KM) focusing on building, disseminating, and sustaining Process Safety Knowledge (PSK) in an organization
- CCPS defines PSK in the PS Glossary as the following:
  - "Knowledge is related to information, which is often associated with policies, and other rule-based facts. It includes work activities to gather, organize, maintain, and provide information to other process safety elements. Process Safety Knowledge primarily consists of written documents such as hazard information, process technology information and equipment-specific information"
- PSKM = PSK + KM

PSKM = PSK + KM

- PSKM is a system for capturing, organizing, maintaining, and providing the right process safety knowledge to the right people at the right time to improve process safety in an organization

Knowledge Pyramid



Data → Information → Knowledge → Wisdom

	INPUTS	OUTPUTS
Data	Safety Data Sheets Test reports Equipment lists	P&ID Flow diagrams Process Safety Information Manuals Hazard Identification and Risk Assessment (HIRA)
Information	P&ID Flow diagrams PSI Manuals HIRA	Risk assessments Controls list Operating procedures Training Emergency plans
Knowledge	Risk assessments Controls list Operating procedures Training Emergency plans	Verification of understanding Validation of competency Revalidation plans Shared learnings External learnings
Wisdom	Verification of understanding Validation of competency Revalidation plans Shared learnings External learnings	Broader learnings Subject matter experts Knowledge sharing Knowledge retention Right decisions

Why PSKM is needed?

Business Case for PSKM

"It might seem to an outsider that industrial accidents occur because we do not know how to prevent them. In fact, they occur because we do not use the knowledge that is available."

Prof. Trevor Kletz

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Business Case for PSKM

- Improved employee and process safety
- Reduced environmental impacts
- Business continuity
- Business agility

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Examples of Financial Benefits of PSKM

- Reduced costs with PHAs
  - AMOCO Oil early 90s justified reduced start up costs by performing multiple PHAs
- Reduced downtime or a process upset by new employees
  - Chevron reported reduced OPEX by $2 billion in 90s by sharing and managing knowledge
- Improved plant reliability and reduced downtime
  - Schlumberger reported $150 million cost savings per year, a 95% reduction in time to resolve technical queries and a 75 percent reduction in time to update engineering modifications by creating a centralized knowledge-based organization
- In an emergency, having an effective PSKM improves business performance
  - Repurposing facilities during COVID pandemic to produce hand sanitizers
  - Ford and 3M partnering to produce air-purifying respirators for health care workers on its auto assembling lines in Michigan

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How to Implement a Successful PSKM Program?

Development, Implementation and Auditing Methods

"Of central importance is the changing nature of competitive advantage - not based on market position, size and power as in times past, but on the incorporation of knowledge into all of an organization's activities"
Leif Edvinsson, Swedish Intellectual Capital guru in Corporate Longitude (2002)

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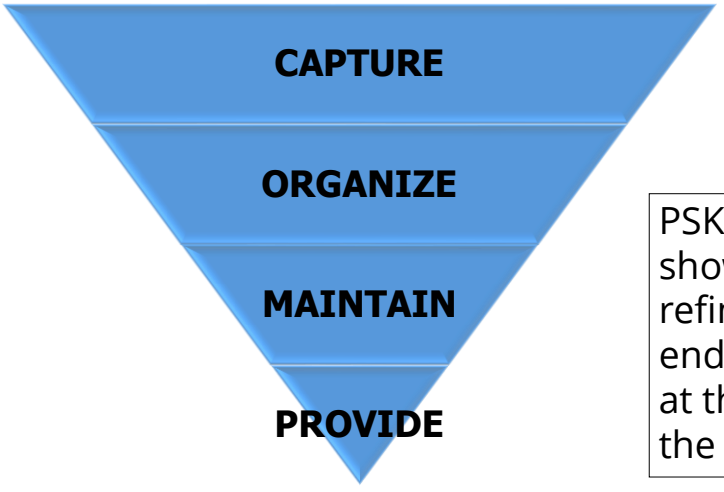
PSKM System



PSKM Triangle inverted to show knowledge funneled, refined and provided to the end-user at the right time, at the right place, and at the right details.

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Core Components of a Successful PSKM Program

Core Component	PSKM Considerations for Long-Term Success
People	Develop skills and competencies so that teams can be productive in the areas of active listening, communication, and critical thinking.
Processes	Develop best practice documents to identify, manage and spread the knowledge.
Technology	Verify tools can be used to enable users to access and update the PSKM.
Organizational Structure	Make certain that organizational structures maintain PSKM across disciplines and expertise.
Culture	Confirm that the organization fosters continued growth and maintains PSK sharing.

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PSKM Implementation Team (An Example)

Role	Responsibilities
Chief Knowledge Officer	Accountable for the overall PSKM strategy, planning and implementation (Highest position within PSKM)
PSKM Project Manager	Executive who manages the implementation of the PSKM initiatives
PSKM Champions	Promote PSKM in the workplace Facilitate Communities of Practice (CoP)
PSKM Navigators	Know where PSKM is located Connect people who need knowledge with systems and people who have knowledge
PSKM Stewards	Responsible for ensuring PSKM updates are made following Management of Change Track changes for follow-up and validation
PSKM Editors	Manage format and language of knowledge so users can easily utilize it

Highlight: Communities of Practice (CoP)

- Communities of Practice (COPs) are organized groups of individuals who share an interest in a defined area and want to coordinate efforts to achieve specific goals. COPs focus on sharing best practices and creating new knowledge to advance the domain of professional practice.

Steps to Implement PSKM

STEP	STEP DEFINITION	PLAN REQUIREMENTS
1	ESTABLISH PSKM PROGRAM OBJECTIVES	Identify and document input needed to meet desired goals
2	PREPARE FOR CHANGE	Prepare for cultural changes to encourage knowledge sharing and Recruit PSKM Champions
3	DEFINE A HIGH-LEVEL PROCESS AS A FOUNDATION	Understand how PSK will be identified, captured, validated, categorized and provided
4	DETERMINE AND PRIORITIZE TECHNOLOGY NEEDS	Assess what kind of technology will improve and automate PSK activities. Understand what employees use today, what works and what does not work
5	ASSESS CURRENT STATE	Assess core components of current PSKM: People, Processes, Technology, Structure and Culture
6	BUILD A PSKM IMPLEMENTATION ROADMAP	Develop milestones and review roadmap based on changing conditions and drivers
7	IMPLEMENT	Celebrate incremental advances and close gaps identified
8	MEASURE AND IMPROVE PSKM PROGRAM	Measure effectiveness by comparing actual results to target results

Resources for PSKM Development

Capturing Knowledge

- Process and Mechanical Design Specifications
- Piping and Instrumentation Diagrams
- Hazard Risk Analyses
- Consequences of Deviation Tables
- RAGAGEP
- Original Equipment Manufacturer Manuals
- Relief System Design and Design Basis
- Material and Energy Balances

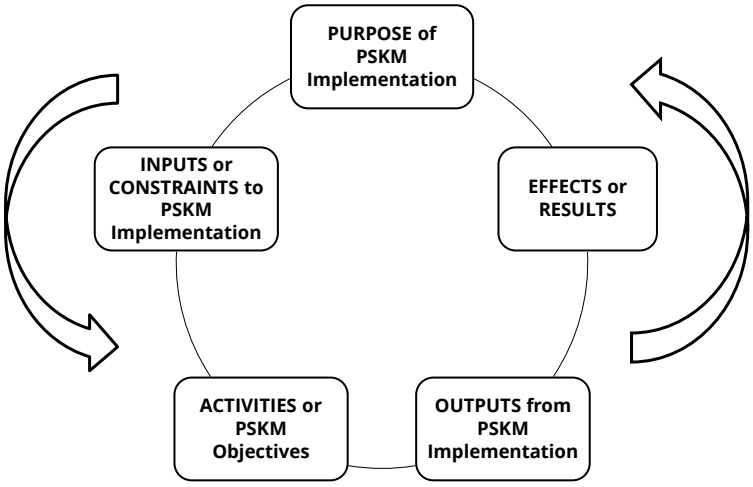
Organizing Knowledge

- Company Intranets
- Skills Directories
- Knowledge Repositories

Providing Knowledge

- Operating Procedures
- Standard Operating Conditions and Limits
- Training
- Chemical Properties and Hazards
- Safety Data Sheets

Logic Models for PSKM Development



Example Logic Model for Capturing the Knowledge

CAPTURE THE KNOWLEDGE				
INPUT SOURCE	CONSTRAINTS	ACTIVITIES	OUTPUTS	EFFECTS
Information Type: CHEMICALS / PROCESS CHEMISTRY / PROPERTIES AND HAZARDS				
Technical Staffing	Budgets	Compilation of Chemical Properties Data from Technical Reports, Safety Data Sheets	Effects of inadvertent mixing of two chemicals evaluated	Inadvertent mixing hazards documented
Information Type: EQUIPMENT DESIGN AND OPERATING LIMITS				
Mechanical Integrity personnel	Time Commitments	Compile Mechanical Design Information	Description of location and operation of controls, maintenance schedules, parts numbers, specifications extracted	Controls, preventive maintenance schedules and parts numbers documented
Information Type: INCIDENTS AND NEAR MISSES				
Incident Reports	Resources	Collect project or process risk, history	History and resolution information collected	Hazard and Risk Registry Documented

Organizing the Process Safety Knowledge

Organization Method	Description	Examples	Advantages	Disadvantages
Location	Visual diagram or map of the information	Emergency Exit Routes, assembly points, etc	Provides orientation and directions	Requires visualization of the facility
Alphabetical or Numerical	Sort by name, department, etc.	Safety Data Sheets Equipment Tags	Useful for sorting large amount of data	Requires prior knowledge
Time	Sorted by time	Incident Database	Helps with sequence	Needs history
Category	Similar information grouped together	PHAs Equipment Tag Descriptions	Grouped by similar importance	User must be aware of the category names and types
Hierarchy	Organized by importance or rank	National Local and Company codes that govern equipment design	Information shown in order of magnitude	May discourage collaboration and information sharing

Tools for Maintaining PSKM System

- Employee Development Program
- Management of Change
- Hazard Registry – Risk Matrix
- Process Safety Community of Practice
- RAGAGEP for Equipment Specific Information
- Maintenance and Inspection Database
- Shared Learning Database
- Corrective Action Tracking System
- Document Management
- PSKM System Audit Program

PSKM System Audit
PSKM Maturity Assessment

Level	Maturity Type	Description
Level 1	Reactive	The organization's knowledge is conceptual, siloed, scattered
Level 2	Dependent	Knowledge repository meets minimum standards
Level 3	Independent	Improvements over time can be demonstrated
Level 4	Optimized	All employees are ambassadors of the system, who contribute to, utilize, and share the system resulting in demonstrable success

* Can be assessed separately for CAPTURE, ORGANIZE, MAINTAIN, and PROVIDE stages

Case Studies and Lessons Learned

Knowledge Management for Incident Investigations

"The major problem with the chemical industry and indeed, with other industries, is the way accidents are investigated; reports are written, circulated, read, filed away and then forgotten. And then ten years later, even in the same company, the accident happens again. There is a saying that organizations have no memory; only people have memory and once they leave the plant, the accident that occurred there is forgotten about."

Trever Kletz, Process Safety guru (1922 – 2013)

Case Studies

- BP Refinery Texas City, TX (2015)

"I looked down the road. It looked like fumes, like on a real hot day, … then, I saw an ignition and a blast. Then my windshield shattered. The roof of the vehicle I was driving caved in on me."

Pat Nickerson, a 28-year veteran of the Texas City refinery

- Concept Sciences (CSI) Hydroxylamine Explosion, Allentown, PA (1999)

"Everything seemed fine. Until it wasn't."

Amy Heller, Victim

- Tesoro Refinery Anacortes, WA (2010)

"We have a saying out there: We don't bake cookies, we boil oil. It can be dangerous."

15-year refinery worker at Tesoro Plant in Anacortes

- DuPont Chemical Facility LaPorte, TX (2014)
- Buncefield Oil Storage Depot, UK (2005)
- Examples from Other Industries

PSKM Focus Chart

- A new graphical tool
- Highlights relationships between the PSKM System elements and various factors that led to the incident
- Summarizes PSKM System Failures

- Proximate Cause: the cause nearest to the incident in time and space.
- Contributing Cause: factors that facilitate the occurrence of the incident.
- Root Cause: A fundamental, underlying, system-related reason why an incident occurred that identifies a correctable failure(s) in management systems

Failures in Providing Knowledge

BP Texas City

	PROXIMATE CAUSE	CONTRIBUTING CAUSES	ROOT CAUSE
PROVIDE KNOWLEDGE	The Raffinate Splitter Tower level was not observed or known during startup resulting in liquid overfill of the tower. ←	Operators did not understand the negative consequences of not following startup procedures including correctly setting and verifying the current positions of critical valves during the startup. ←	The management did not provide experienced and technically trained personnel that would communicate the hazards during unit startup.

Failures in Maintaining Knowledge

	PROXIMATE CAUSE	CONTRIBUTING CAUSES	ROOT CAUSE
PROVIDE KNOWLEDGE	The Raffinate Splitter Tower level was not observed or known during startup resulting in liquid overfill of the tower. ←	Operators did not understand the negative consequences of not following startup procedures including correctly setting and verifying the current positions of critical valves during the startup. ↑ ←	The management did not provide experienced and technically trained personnel that would communicate the hazards during unit startup.
MAINTAIN KNOWLEDGE		Operators either did not know or share that level control instruments could not be relied upon since they were prone to failure. ←	Operator training program was inadequate.

Failures in Organizing Knowledge

	PROXIMATE CAUSE	CONTRIBUTING CAUSES	ROOT CAUSE
PROVIDE KNOWLEDGE	The Raffinate Splitter Tower level was not observed or known during startup resulting in liquid overfill of the tower.	Operators did not understand the negative consequences of not following startup procedures including correctly setting and verifying the current positions of critical valves during the startup.	The management did not provide experienced and technically trained personnel that would communicate the hazards during unit startup.
MAINTAIN KNOWLEDGE		Operators either did not know or share that level control instruments could not be relied upon since they were prone to failure.	Operator training program was inadequate.
ORGANIZE KNOWLEDGE		Operators were biased towards avoiding low level in the tower instead of potential issues with high levels.	BP Texas City did not create an effective reporting and learning culture.

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MAINTAIN KNOWLEDGE		Operators either did not know or share that level control instruments could not be relied upon since they were prone to failure.	Operator training program was inadequate.
ORGANIZE KNOWLEDGE		Operators were biased towards avoiding low level in the tower instead of potential issues with high levels.	BP Texas City did not create an effective reporting and learning culture.
CAPTURE KNOWLEDGE		Similar recurring operational problems were not recognized as deviations from normal operations.	Lessons learned from Texaco Milford Haven Refinery in the United Kingdom in 1994 were not captured.

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Summary

- PSKM = PSK + KM
- PSKM is critical for sustainable and safe business operations
- PSKM System should focus on Capturing, Organizing, Maintaining and Providing Knowledge
- Tools are available for implementing a successful PSKM Program (Logic Models and PSKM Focus Charts)
- PSKM Audit is needed to assess the program maturity and identify further improvements for a healthy PSKM System

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Guidelines for Process Safety Knowledge Management 1st Edition

by CCPS (Center for Chemical Process Safety) (Author)

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Hardcover
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This book contains guidelines for companies to improve their process safety performance through the implementation of a Process Safety Knowledge Management (PSKM) system. The book defines the characteristics of a PSKM system as well as guidelines on how to set a PSKM system to improve overall Process Safety performance. The underlying factors for success are presented which include leadership, employee involvement, and organizational culture with case studies used to illustrate key points and learnings. The book also contains new perspectives on PSKM and describes how to overcome difficulties in the transition from a process safety culture based on data and information to a culture based on knowledge and wisdom. The book also contains case studies with PSKM-related lessons learned.

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Thank you for your attention!

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