

Effective Procedural Practices: A Review of the ASM Consortium Guidelines and Related Studies



Dr. Peter Bullemer
Human Centered
Solutions (HCS)

Liana Kiff
Honeywell Labs

ASM Consortium Webinar Series

- **Dr. Peter Bullemer**

- Senior Partner, HCS, human factors consulting group
- Ph.D. in Cognitive Science
- Participation in ASM program since 1993, including roles as Director and Principle Investigator



- **Liana Kiff**

- Sr. Principal Research Scientist, Honeywell Advanced Technology
- Specializes in information models and decision support
- Program Manager for the Abnormal Situation Management® (ASM®) Consortium



- **This webinar aims to:**
 - Present background information on the [ASM Consortium](#)
 - Review findings from research into the culture of procedural use
 - Review findings from research of procedure execution failures under abnormal situations
 - Present overview of the contents of the Effective Procedure Practices guidelines document
 - Highlight specific guidelines related to key challenges in achieving effective procedural operations



Abnormal Situation Management

A Joint Research & Development Consortium

Founded in 1994

- Creating a **new paradigm** for the operation of complex industrial plants, with **solution concepts** that improve Operations' ability **to prevent and respond to abnormal situations**.
- Enabling proactive operations to **maximize process safety and minimize environmental impact** while allowing the processes to be pushed to their optimal limits.

www.asmconsortium.org



ConocoPhillips

ExxonMobil



SASOL
reaching new frontiers



Shell



TOTAL

Uop

A Honeywell Company

Honeywell

Human Centered Solutions

Helping People Perform



PENNSTATE



UCLA

- An industrial process is being **disturbed** and the automated control system **can not cope**
- Consequently, the operations team **must intervene** to supplement the control system.



An Abnormal Situation Impacts Process Safety



ASM Relation to PSM

Safety Pyramid Illustration

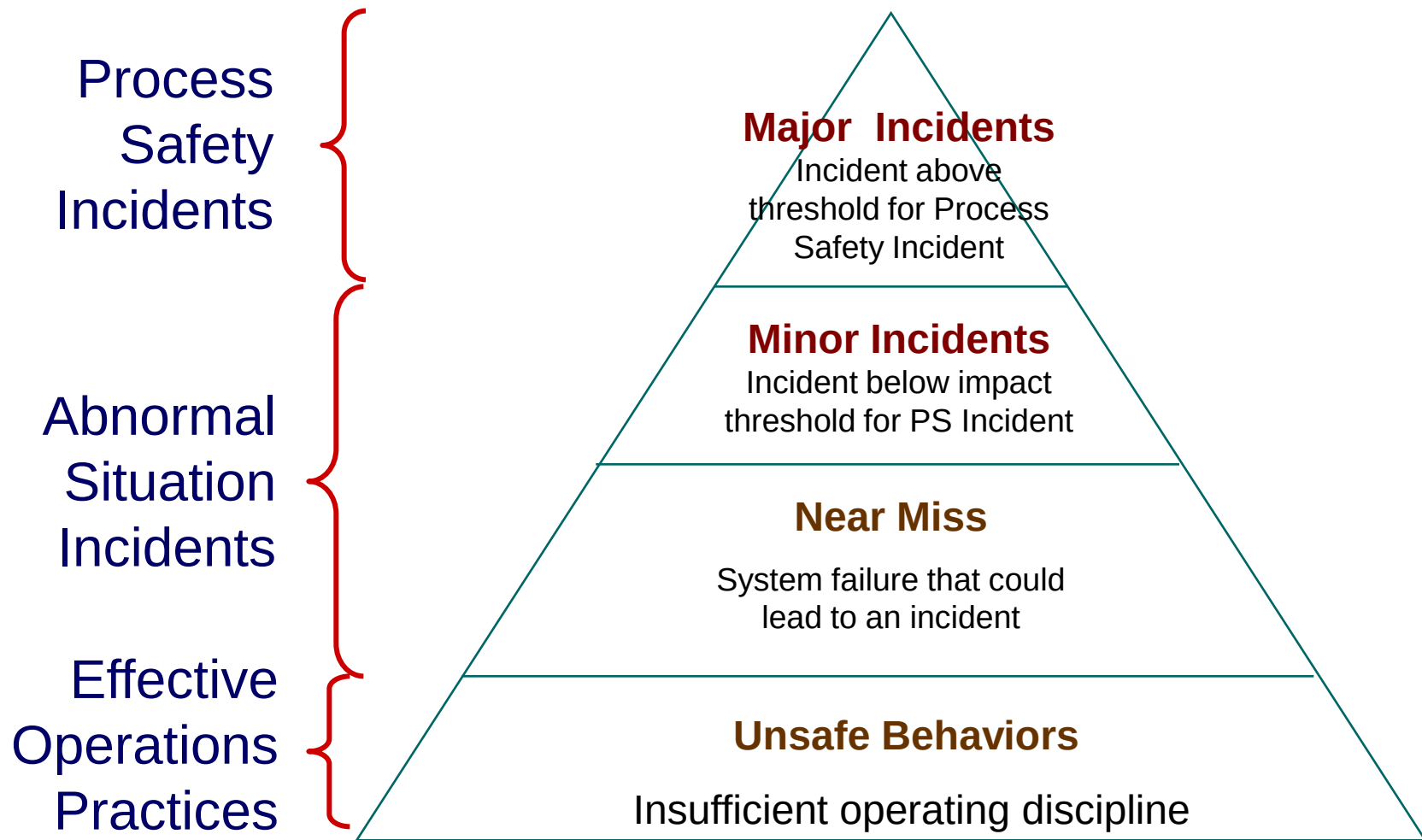
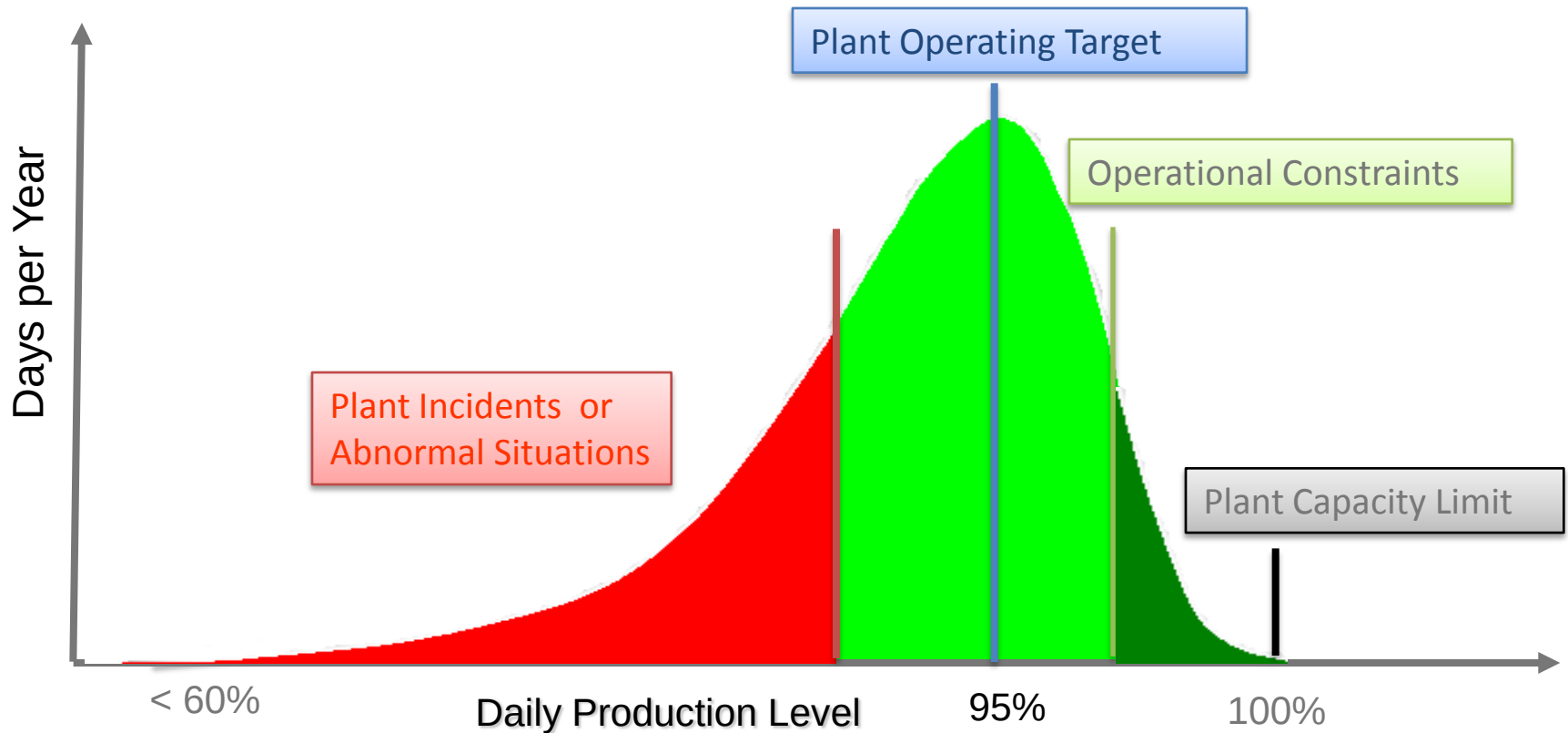


Illustration based on: CCPS *Process Safety Leading and Lagging Metrics*.



ASM Consortium

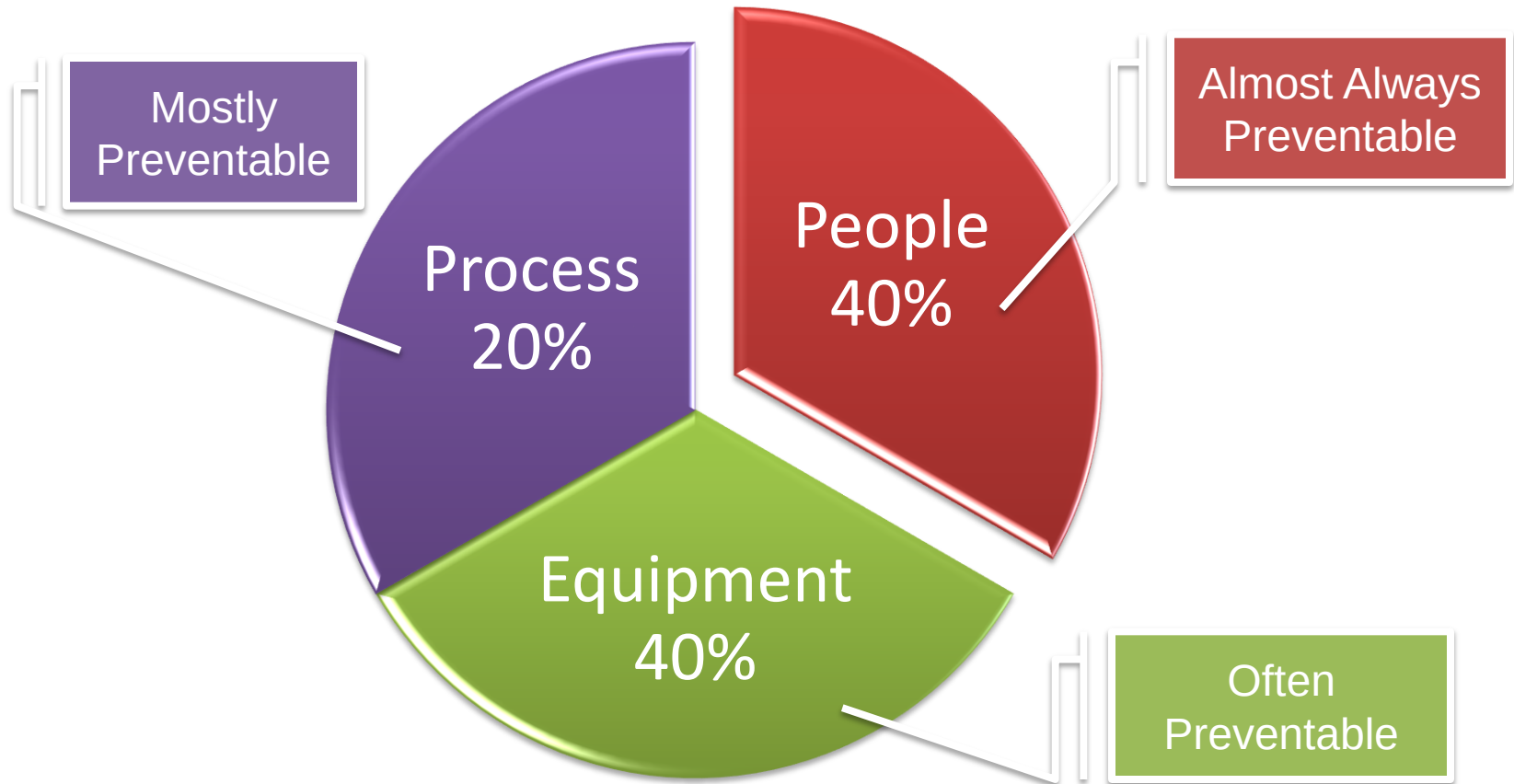
Cost of Abnormal Situations

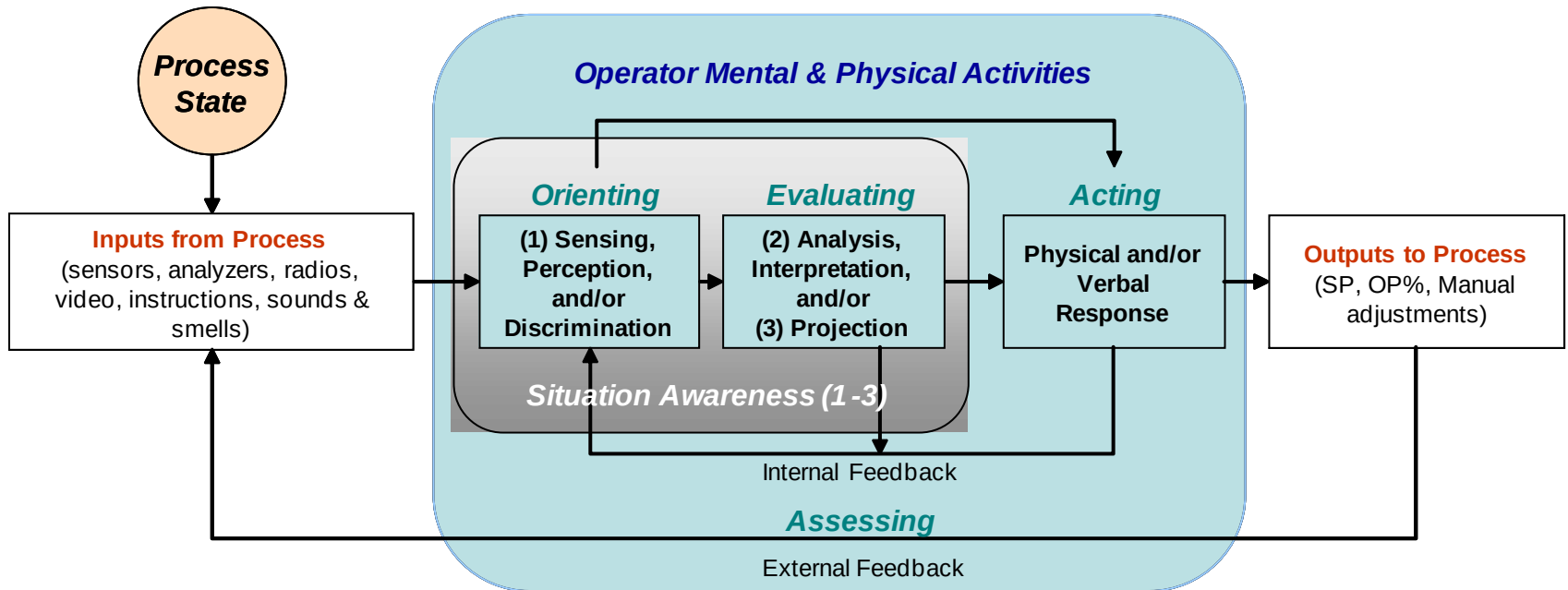


- Unexpected Events Cost 3-8% of Capacity
- At least **\$10B annually lost** in production*

*Based on North America operations ~1992

- The ASM Consortium **develops solutions** *primarily* to address 'People' sources of abnormal situations





- This model operationalizes the activity types in the **operator's supervisory control responsibilities** for managing abnormal situations

Adaptation of Supervisory Control Activity models of Jens Rasmussen and David Woods - CMA.



Related ASM Research Studies

- 2000 Culture of Procedure Use
- 2004 Procedure Use Practices
- 2007-8 Root Cause Analysis of Industry Incidents
- 2009 Procedure Execution Failures under abnormal situations

- 2000 Culture of Procedure Use Study
- Culture related challenges
 1. High costs associated with procedure maintenance
 - Related to frequency of plant changes and mandatory reviews
 2. Access to procedures has been a problem
 - Related to large number and binder storage
 3. Procedures tend to be used infrequently
 - Related to access and perceived need
 4. Perception that procedures are typically out-of-date
 - Accurate or not – justification for not using procedures
 5. Uncertain criteria for OSHA regulatory compliance
 - Criteria for compliance is open to interpretation – seems to provide the primary motivation for procedure development activities

- 2004 Procedure Use study
- **Understand contributors to effective procedure operations**
- **Findings on impact of ineffective use of procedures**
 - Only 3 of 5 sites had incident data available on procedure root causes
 - Only 1 of 5 sites had data on the cost of ineffective procedure use

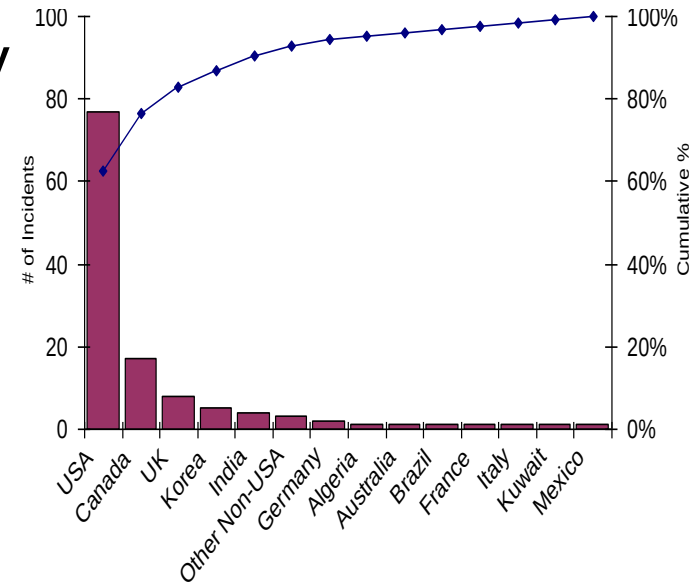
Site	% of Incidents	Annual Cost
1	14%	\$2.5M
2	31%	?
3	10%	?
4	?	?
5	?	?

Reported Causes	%
Incomplete coverage	43%
Procedure NOT followed	28%
Flawed reasoning	14%
Incorrect procedure	6%
Incorrect use of procedure	4%
Inadequate coordination	3%
Incorrect facts/data	2%

- **71% of reported causes** related to Incomplete Coverage and Not Following Procedures

- General lack of compliance with policy on procedural use
 - Typical plant policy requires following procedures at all times
 - » If the procedure is non-routine or complex, operators are expected to use the procedure for planning and execution, and initial the steps as they are completed.
 - » If the procedure is routine, operators are expected to know and follow the procedure.
 - » If the procedure is an emergency type, operators are expected to know the initial steps and then reference the procedure in completing the remaining steps.
 - Lack of procedure classification leaves the decision to pull a procedure up to the judgment of the operators and supervisors
- General poor understanding of sources of ineffective procedural use
 - Typical plant incident reporting system provides only general indication of the impact
 - Results in poor guidance for continuous improvement of procedure management system

- 2007-8 Root Cause Analysis Study
- **Understand relation between ineffective operations practices and process industry incidents**
 - Systematically **analyze incidents** to determine common operational practice failure modes
 - Identify **root causes** of common operational practice failure modes
 - Why do failures occur ACROSS incidents



	Public	Site	Total
USA	14	7	21
Non USA	6	5	11
Total	20	12	32

- **Failure** is any operational practice flaw that, if corrected, could have prevented the incident from occurring or would have significantly mitigated its consequences
 - What went wrong in the specific incident in the investigation team's own language/terms
 - Example: Supervisor not accessible
- **Common failure modes** are shared operational practice failures across incidents
 - Common problems for the industry (or site)
 - Failures map to *ASM Effective Operations Practices* Guidelines
 - Example: Ineffective first line leadership roles

Effective Operations Practice Areas	% of Failures
Understanding Abnormal Situations	4%
Organization Roles, Resp. & Work Processes	53%
Knowledge & Skill Development	7%
Communications	17%
Procedures	8%
Work Environment	1%
Process Monitoring, Ctrl, & Support Applications	10%

- **8% of failures** associated with ineffective procedural practices
- Based on a total of 539 practice failures across 32 incident reports

Top 10 Operations Failures	#	%
Hazard analysis/ communication	79	15%
First-line leadership	65	12%
Continuous improvement	60	11%
Safety culture	36	7%
Initial and refresher training	30	6%
Task communications	29	5%
Comprehensive MOC	28	5%
Cross functional communication	23	4%
Compliance with procedures	15	3%
Design guidelines and standards	14	3%
Other failure modes	160	30%
TOTAL	539	

- **#9** failure mode was Failure to Comply with Procedure Policy on Use
- **# 4** Safety Culture also includes ineffective use of procedures

- A **root cause** is the most basic cause (or causes) that can reasonably be identified that management has control to fix and, when fixed, will prevent (or significantly reduce the likelihood of) the failure's (or factor's) recurrence
 - 'Why' a failure occurred
 - Root causes were identified using the TapRoot® methodology
 - Procedure related examples:
 - » *Procedure followed incorrectly,*
 - » *Procedure wrong,*
 - » *Procedure not used.*

Root Cause Category	#	%
Management System	233	28%
Work Direction	140	17%
Communications	122	15%
Procedures	70	8%
Training	59	7%
Human Engineering	49	7%
Quality Control	22	3%
Equipment-related Sources	147	17%
Totals	842	100%

- **83%** of root causes were human performance related
- **8%** associated with ineffective use of procedures

Procedure Category		#	%
Procedure Not Used/Not Followed	Not used	19	27%
	No procedure	15	21%
	No access or inconvenient	1	1%
	Difficult to use	1	1%
Procedure Wrong	Situation not covered	25	36%
	Facts wrong	3	5%
Procedure Used Incorrectly	Check off misused	3	5%
	Details need improvement	2	3%
	Format confusing	1	1%
Totals		70	100%

- Top 3 sources account for 84% of procedure related root causes



Procedure Execution Failures during Abnormal Situations

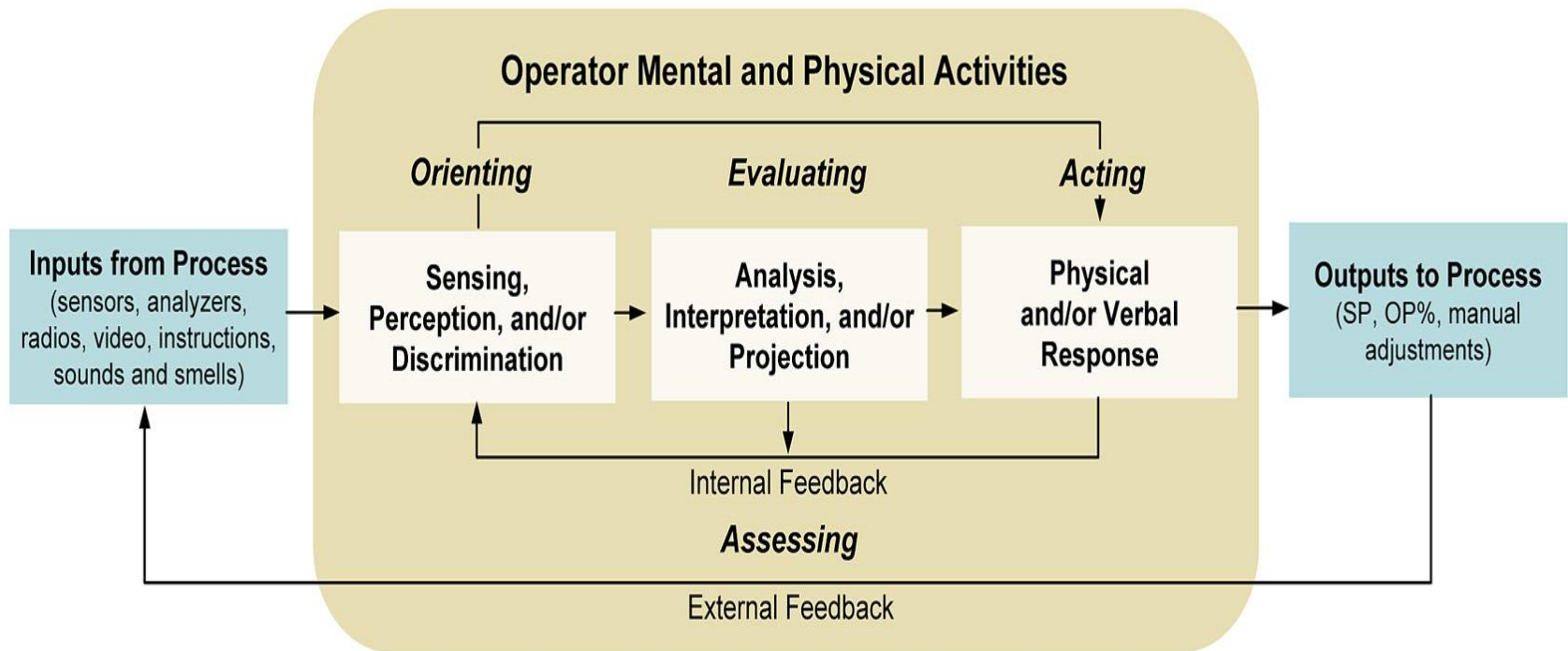
- 2009 Procedure Execution during Abnormal Situations Study
- **Understand the nature of common failure modes in the application or execution of procedures, either manual or automated, during or in response to an abnormal situation**
 - Re-examine previous root cause manifestations to determine the extent to which failures were associated execution under an abnormal situation
 - If the failure occurred prior to the occurrence of an abnormal situation, the root cause was NOT considered relevant to the study

Root Cause Analysis Results

Procedure Root Cause Summary Table			
Root Cause Category	Subcategory	Count	ASM Relevance
Procedure Followed Incorrectly	Format confusing	1	1 of 1; 100%
	> 1 action / step	0	No
	Excess references	0	No
	Mult unit references	0	No
	Limits NI	0	Yes
	Details NI	2	0 of 2; 0%
	Data/computations wrong or incomplete	0	No
	Graphics NI	0	No
	No Checkoff	0	No
	Checkoff Misused	3	1 of 3; 33%
	Misused second check	0	No
	Ambiguous instructions	0	Maybe; No examples found
	Equipment identification NI	0	No
	Category Subtotal	9%	Somewhat: 2 of 6; 33%
Procedure Wrong	Typo	0	No
	Sequence wrong	0	No
	Facts wrong	3	2 of 3; 66%
	Situation not covered	25	20 of 25; 79%
	Wrong revision used	0	No
	Second checker needed	0	No
	Category Subtotal	40%	Mostly: 22 of 28 (79%)
Procedure Not Used/Not Followed	Procedure not used	19	9 of 19; 47%
	No procedure	15	7 of 15; 47%
	Procedure not available or inconvenient for use	1	0 of 1; 0%
	Procedure difficult to use	1	0 of 1; 0%
	Category Subtotal	51%	Moderate: 16 of 36 (44%)
All Procedures	100%	70	Majority: 40 of 70 (57%)

- The majority of root causes were associated with the failure to execute under abnormal situations
- 57% (40 of 70) of all procedure related root causes

- A root cause **manifestation** is the specific expression or indication of a root cause in an incident
 - ‘How’ execution failures are expressed in real operations settings
 - A common manifestation is an abstraction of similar individual root cause manifestation across incidents
 - Example: *Supervisor not in control room to discuss problems* is an example common manifestation for the *No Supervision* common root cause



- Common manifestations abstractions were developed based on ASM Operations Intervention Model of operator supervisor control activities

- Orienting Failures
 - Fail to detect abnormal condition
 - Fail to detect an abnormal situation
- Evaluating Failures
 - Unaware of process or equipment hazard
 - Lack understanding of impact of actions
- Acting Failures
 - Execute inappropriate action
- Assessing Failures
 - None were identified

- Common manifestations for procedure execution failures under abnormal situations:

Common Manifestations	#	Definition
Inappropriate action	15	Failure to know what the appropriate response should be to the occurrence of an abnormal situation in the execution of the procedure
Fail to detect abnormal condition	12	Failure to detect whether equipment or process is abnormal mode; or whether there are any latent abnormal conditions
Lack understanding of impact	8	Failure to understand the correct impact or effect of a procedural action or failure to know the impact of not following procedural instruction
Fail to detect abnormal situation	4	Failure to know when normal operating range is exceeded; or know the indications of the occurrence of an abnormal situation
Unaware of hazard	1	Failure to know about the existence of a hazard or the potential of a hazardous situation if a step or steps are not followed as specified
Total	40	

- Examine root cause and manifestations to aid understanding of possible mitigations for these types of procedure execution failures

Root Case Subcategory	Count	Common Manifestations (Count)
Situation Not Covered	20 of 25	Inappropriate Action (7) Fail to Detect Abnormal Conditions (7) Lack Understanding of Impact (5) Fail to Detect Abnormal Situation (1)
Procedure Not Used	9 of 19	Inappropriate Action (4) Fail to Detect Abnormal Conditions (3) Lack Understanding of Impact (2)
No Procedure	7 of 15	Inappropriate Action (4) Fail to Detect Abnormal Situation (2) Fail to Detect Abnormal Conditions (1)
Facts Wrong	2 of 3	Fail to Detect Abnormal Situation (1) Lack Understanding of Impact (1)
Check-off Misused	1 of 3	Fail to Detect Abnormal Conditions (1)
Format Confusing	1 of 1	Unaware of Hazard (1)



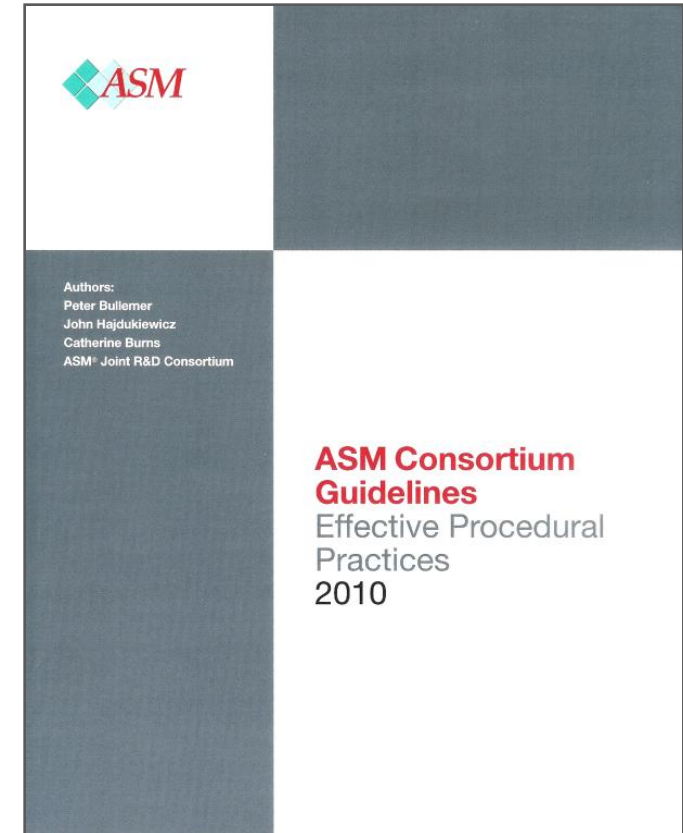
Corrective Action Summary

- In 59% of these incident reports, the investigation team observed a strong need to address abnormal situations in procedure development

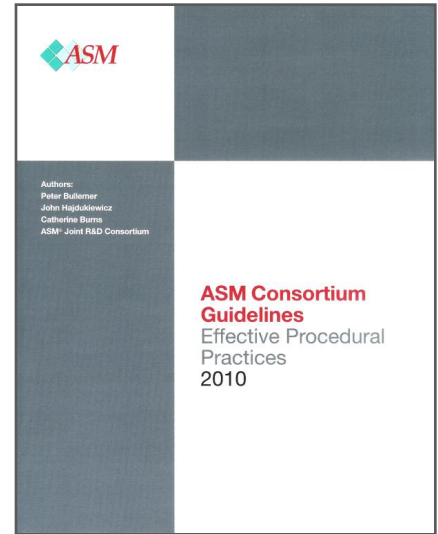
Incident Report Corrective Action Recommendations	Frequency
Improve procedure content by addressing abnormal situations	19
No procedure mitigation strategy recommended in report	13
Improve procedure coverage	10
Improve procedure content	4
Improve policy enforcement	3
Improve procedural training	3
Improve development method	2
Improve procedure format	1
Improve review work process	1
Improve status documentation	1

- Ineffective procedure use is a significant contributor to process safety incidents
 - Need to go beyond regulatory compliance to address failures associated with abnormal situations
- Despite large investments in procedural management systems, the process industries are NOT obtaining desired benefits
 - Lack of good metrics → Lack of awareness of sources of breakdowns → Lack of appropriate improvements → Lack of benefits
- Application of human factors principles and methodologies are key to enabling effective practices
 - Significant opportunity to improve on today's practices

- The *Effective Procedural Practices* is a **comprehensive set of recommended practices** that acknowledge the complexity of the challenges identified in ASM Consortium studies.
 - 1st edition in 2003 for ASMC members
 - 2nd edition in 2007 for ASMC members
 - 3rd edition in 2010 available to public for purchase



- Communicate the ASM® Consortium recommendations for the effective development and use of procedural practices
- Enable assessment of the quality of a company's procedural practices from the perspective of their potential impact on abnormal situation management
- Guidelines describes “what to do,” but is not intended to be a “how to guide” to the design of the plant policy or work processes
- Examples support understanding the guideline recommendations, but may NOT represent the best implementation for your site



- The *Effective Procedural Practices* guidelines are organized under five categories:
 - **Development** guidelines include processes and methods for creating procedures, defining types, documenting competencies requirements, ensuring consistent effective tools;
 - **Content and Format** guidelines address scope of procedures, information to be included in procedure, and appropriate content and formats for conditions of use;
 - **Deployment** guidelines suggest approaches and techniques to enable effective access and use of procedures including the use of performance support and automation;
 - **Maintenance** guidelines on how procedures are prioritized and maintained through the Management of Change process, review processes, and the use of procedure-based metrics;
 - **Training** guidelines cover understanding site policies, adequate training for procedural changes, certification, and simulator-based training solutions.

Each of the guidelines has been assigned a priority rating:

- *Priority 1* – rated as one of the **minimum** set of guidelines for achieving an ASM good quality practice.
- *Priority 2* – one of the **comprehensive** set of guidelines for achieving an ASM high quality practice.
- *Priority 3* – one of the **advanced** set of guidelines for achieving an ASM best practice.

Guideline Category	Total	Priority 1	Priority 2	Priority 3
1. Development	7	4	3	0
2. Content & Format	11	7	3	1
3. Deployment	8	2	1	5
4. Maintenance	6	2	3	1
5. Training	7	3	2	2
Totals	39	18	12	9



Guideline Content Review

- Next few slides show:
 - A Guideline description for each of the five practice areas
- Illustrate the information elements associated with each guideline
 - Guideline statement
 - Guideline priority
 - Why?
 - How it Works

- **Objective:** Establish procedure development methodologies that generate effective procedures.
- **Rationale:** Effective development methods can ensure procedures are thorough and complete. In addition, development methods that ensure a consistent format can reduce the effort to update procedures. Ultimately, the use of effective development methods can increase the use of procedure documents appropriate to the associated operational, environmental, and safety risks.
- This section has 7 guidelines



Development Category

Risk-based Classification

Guideline #1.5	Establish risk-based criteria for procedural use classification.	Priority 2
Why?	❖ Help sites prioritize procedures for development, format, use, review, training, and technology development (for example, procedure automation). ❖ Establish formal expectations for use of procedures such as whether sign-offs are required, whether checklists should be used, and whether or not the procedure must be in-hand during the execution. ❖ A policy that explicitly requires in-hand use of procedures for all procedural operations leads to a high level of non-compliance. ❖ A demonstrated effective approach is to categorize procedures by risk and then establish conditions for their use appropriate to the risk level.	



Development Category

Risk-based Classification

Guideline #1.5	Establish risk-based criteria for procedural use classification.	Priority 2
How it Works	Rate procedures with numbers based on • Expected frequency of use • Complexity • Consequences From these ratings, develop a risk score for each procedure. Categorize procedures into three classes: • Critical – typically low frequency, highly complex, and serious consequences • Reference – typically moderate frequency, complexity, consequences • Guidelines – typically high frequency, low complexity and minor consequences Develop policies for each category of procedure that describe whether: • The procedure requires review prior to use • The procedure needs to be <i>in hand</i> during the operation • The procedure requires step by step verification with initials • The procedure requires sign off following completion • The procedure should be partially or fully automated	

- **Objective:** Ensure that procedures cover appropriate operations activities adequately using content and formats that best match the conditions of use.
- **Rationale:** An effective procedure management system provides procedural instruction across the scope of modes of operation with content that aids operators in performing activities safely, efficiently and consistently.
- This section has 11 guidelines



Content & Format Category

Expected Deviation Response

Guideline #2.9	Address appropriate responses to foreseeable deviations during procedure execution.	Priority 2
Why?	❖ Provides the operator with appropriate actions to deal with predictable deviations from a procedure ❖ Helps the operator identify situations that necessitate the forced abandonment of a procedure.	



Content & Format Category

Expected Deviation Response

Guideline #2.9	Address appropriate responses to foreseeable deviations during procedure execution.	Priority 2
How it Works	❖ In any procedure, deviations or events can occur that make the basic procedure no longer relevant. ❖ Anticipate these events, think through scenarios wherever possible and provide the operator with alternative steps, or refer the operator to an alternative procedure. ❖ Identify possible deviations and abnormal events by looking for deviations that could have significant consequences, or by examining what deviations have occurred in the past. ❖ For online procedures, provide handlers to cover these scenarios such that the aborted procedure does not leave elements of the process in an abnormal operating state.	

- **Objective:** Ensure effective practices for managing the access and use of procedures.
- **Rationale:** Deployment practices determine how easy or effortful it is for operators to access and use the most up-to-date version of a procedure. In addition, there may be multiple formats, media and conditions for use that may need to be supported as well.
- This section has 8 guidelines



Deployment Category

Procedure Deviation

Guideline #3.2	Empower operators to deviate from the procedure under specific circumstances, however, deviations should be logged and reviewed.	Priority 1
Why?	❖ Not all situations during procedure execution can be anticipated and therefore cannot be addressed <i>a priori</i> in a procedure. ❖ An operator may, in abnormal situations or off-normal equipment configurations, be required to deviate from a procedure to take the best possible action. ❖ Logging and reviewing these deviations allow these circumstances to be discussed, or procedures to be improved.	

How it Works	
	❖ When an operator determines a need to deviate from the expected operation of the procedure, a Management of Change process should be used to determine a formal risk assessment is needed before implementation. ❖ A Management of Change process should ensure all affected personnel are aware of the need to deviate. ❖ The Management of Change process may need to account for decisions required in a relatively quick timeframe, and therefore may be seen as a 'fast-track' process involving supervisor approval or other expert review. ❖ In addition, the deviation from the procedure is logged and reviewed as part of a continuous improvement process to avoid problems in the future.

- **Objective:** Maintain procedures properly through plant configuration changes
- **Rationale:** Maintenance practices ensure that procedures evolve appropriately with plant configuration changes and improve as a result of learning from experience
- This section has 6 guidelines



Maintenance Category

Procedure-related Metrics

Guideline #4.6	Define metrics to track the impact of procedural operations and integrate with the incident reporting system.	Priority 3
Why?	❖ Metrics that track the impact of procedural operations can help with the identification of opportunities for continuous improvement. ❖ Understanding how procedural practices impact plant safety, reliability and profitability is essential to making continuous improvements to effectiveness of procedures.	



Maintenance Category

Procedure-related Metrics

Guideline #4.6	Define metrics to track the impact of procedural operations and integrate with the incident reporting system.	Priority 3
How it Works	A systematic analysis of the ways a procedural system may be improved may provide the foundation for a set of metrics to measure effectiveness. It is important that the metrics provide information on where improvements need to be made, such as: • Policy on use of procedure not followed • Inconvenient or no access from job location • Inappropriate format for conditions of use • Incomplete or inaccurate instructions • Insufficient warning of hazards • Incomplete coverage of activities • Insufficient time to perform procedure • Inadequate coordination or communication • Ineffective handling of deviation • Error in support application software	



Maintenance Category

Procedure-related Metrics

Guideline #4.6	Define metrics to track the impact of procedural operations and integrate with the incident reporting system.	Priority 3
How it Works	For the best understanding, these opportunities should be supplemented with information on: • Frequency of occurrence • Estimated cost of the missed opportunity • Criticality of safety in the missed opportunity To understand the quality of developed procedures and how much operators must deviate from the procedures, consider also collecting information on: • Number of operator interventions during procedure execution • Number of alarms associated with procedure execution.	

- **Objective:** Develop operators' knowledge and skills for effective use of procedures.
- **Rationale:** Training practices ensure that operators can execute the procedural instructions in a safe and efficient manner as well as understand the rationale underlying the elements of the procedural management system.
- This section has 7 guidelines



Training Category

Communicate Impact

Guideline #5.6	Distribute periodic reports on the impact of procedural operations on safety, environment and production.	Priority 3
Why?	❖ Periodic reports on procedure performance provide feedback on areas for improvement. ❖ In a continuous learning environment, individuals benefit from feedback on how their behavior impacts plant performance relative to safety, environment, and production goals. ❖ When individuals see the incident reporting system used effectively to help improve overall performance, they will be more inclined to take the time to log events.	

Guideline #5.6	Distribute periodic reports on the impact of procedural operations on safety, environment and production.	Priority 3
How it Works	❖ Capture procedure related metrics on a consistent basis ❖ Generate periodic reports to the operation personnel to develop understanding of strengths and weaknesses of the procedural operations. ❖ Include information on impact as well as sources of failures ❖ The shared understanding of how a specific management system such as procedural operations impacts performance goals enables individuals to work jointly to identify continuous improvement opportunities in the procedure management system. ❖ Generating periodic summary reports also reinforces consistent and honest reporting to the incident database.	

- 1. Guideline Checklists*
- 2. Influence of Culture*
- 3. Procedural Operations Failure Analysis*
- 4. Abnormal Situation Management Impact*
- 5. Implementation Services*
- 6. ASM Members*



How to Use the Guidelines

- Auditing existing practices
 - Gap analysis for opportunities for improvement
- Establishing consistent procedural practices
 - Incorporation into a company's own guidelines
 - A guide to setting up or improving a site's procedure practices
- Educating site personnel on effective procedural practices
 - Management and supervision, individuals who establish or assist in establishing company policies and work processes
 - Members of the team(s) that develop and deploy procedures



ASM Consortium Publications

Presentation References & Related Works

- Bullemer, P.T. and Hajdukiewicz, J. (2004). A study of effective procedural practices in refining and chemical operations. *Proceedings of the Human Factors and Ergonomics Society's 48th Annual Meeting*. New Orleans, LA.
- Bullemer, P., Hajdukiewicz, J., and Burns, C., (2010). *Effective Procedure Practices*. ASM Consortium Guidelines. Minneapolis, MN: ASM Consortium. Available at createspace.com
- Bullemer, P.T., Kiff, L. and Tharanathan, A. (2010). Common procedural execution failure modes during abnormal situations. Presentation at Mary Kay O'Conner Process Safety Center International Symposium. College Station, TX.
- Bullemer, P.T. and Laberge, J.C. (2010). *Abnormal Situation Management and the human side of safety*. Paper presented at the 15th Annual Meeting of the European Refining Technology Conference. Istanbul, TR.
- Bullemer, P.T. and Laberge, J.C. (2010). Common operations failure modes in the process industries. *Journal of Loss Prevention in the Process Industries*, 23(6), 928-935.
- Guerlain, S., and Bullemer, P.T. (2000). Critiquing team procedure execution. *Proceedings of the Human Factors and Ergonomics Society 44th Annual Meeting*, San Diego, CA.
- Jamieson, G. and Miller, C. (2000). Exploring the culture of procedures. *Proceedings of the 5th International Conference on Human Interaction in Complex Systems*. Urbana, IL.

- **Thank you for attending this webinar**
 - A recording of this webinar will be made available soon
 - We will send an email with a link to all registered attendees
- **Please contact us at:**
 - Peter Bullemer - pbullemer@applyHCS.com
 - Liana Kiff – liana.kiff@honeywell.com
- **ASM Members may register for access to ASM Research and Guidelines at www.asmconsortium.org**
- **Non-members may purchase ASM Guidelines documents from:**
www.createpace.com, or
www.amazon.com