Guidelines for Auditing Process Safety Management Systems

Second Edition

Center for Chemical Process Safety
New York, New York

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This book is one in a series of process safety guideline and concept books published by the Center for Chemical Process Safety (CCPS). Please go to www.wiley.com/go/ccps for a full list of titles in this series.

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☼ **ADDITIONAL ONLINE MATERIAL**

The templates, samples, and protocols for Appendices A–G are provided electronically for the user's convenience. See those appendices for more information on the substance and format of the material.

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ACRONYMS

3133	OSHA Publication 3133, *Process Safety Management Guidelines for Compliance*
ACA	Apparent Cause Analysis
ACC	American Chemistry Council
AGA	American Gas Association
AI	Asset Integrity
AIChE	American Institute of Chemical Engineers
ALARA	As low as reasonably achievable
ALARP	As low as reasonably practicable
ANSI	American National Standards Institute
API	American Petroleum Institute
APPC	Appendix C of OSHA's PSM Standard (Compliance Guidelines and Recommendations for Process Safety Management) (Nonmandatory)
ARS	Alternative release scenario
ASME	American Society of Mechanical Engineers
ASNT	American Society of Non-Destructive Testing
BEAC	Board of Environmental, Health, and Safety Auditor Certifications
B&PV	Boiler & Pressure Vessel Code
CAD	Computer-aided design
CalARP	California Accidental Release Prevention (Program)
CalOSHA	California Occupational Health and Safety Administration
CAPP	Chemical Accident Prevention Program (Nevada)
CBT	Computer-based training
CCC	Contra Costa County
CCPA	Canadian Chemical Producers Association
CCPS	Center for Chemical Process Safety
CDC	Centers for Disease Control
CEI	(Dow) Chemical Exposure Index
CEU	Council of the European Union
CIT	Citation (issued by regulator)
CML	Condition measurement location
CMMS	Computerized maintenance management system
COMAH	Control of Major Accident Hazards
CPL	Compliance directive (OSHA instruction)

CSCC	Chloride stress corrosion cracking
CSChE	Canadian Society of Chemical Engineers
CUI	Corrosion under insulation
CV	Curriculum vitae
DCS	Distributed control system
DIERS	Design Institute for Emergency Relief Systems
DOI	Department of Interior
DOT	Department of Transportation
DIERS	American Institute of Chemical Engineers—Design Institute for Emergency Relief Systems
EHSRMA	Extremely Hazardous Substances Risk Management Act (Delaware)
E&P	Exploration and production
EAP	Emergency action plan
EHS	Environmental, health, and safety
EMS	Emergency medical services/environmental management system
EOP	Emergency operating procedure
EPA	Environmental Protection Agency
ERP	Emergency response plan
ERT	Emergency response team
ESD	Emergency shutdown system
FEI	(Dow) Fire and Explosion Index
FFS	Fitness for service
FM	Factory Mutual
FMEA	Failure modes and effects analysis
GDC	General duty clause
GIP	Good industry practice (in PSM)
HAZCOM	Hazard Communication (Standard—a U.S. regulation)
HAZOP	Hazard and Operability (Study)
HAZWOPER	Hazardous Waste Operations and Emergency Response (Standard—a U.S. regulation)
HF	Hydrogen fluoride or hydrofluoric (acid)
HIRA	Hazard Identification and Risk Analysis
HSE	Health and Safety Executive (United Kingdom)
HVAC	Heating, ventilating, and air conditioning
HWP	Hot work permit
ICP	Integrated contingency plan
IDLH	Immediately dangerous to life and health
I/E	Instrument/electrical
IFSTA	International Fire Service Training Association
ILO	International Labor Organization
IPL	Independent protection layer
ITPM	Inspection, testing, and preventive maintenance
ISA	International Society of Automation (formerly Instrument Society of America)

ISO	International Standards Organization, Industrial Safety Ordinance (CCC)
IST	Inherently safer technologies
LEPC	Local Emergency Planning Committee
LNG	Liquified Natural Gas
LOPA	Layer of protection analysis
LOTO	Lockout/tagout
MI	Mechanical Integrity
MIACC	Major Industrial Accident Council of Canada
MKOPSC	Mary Kay O'Connor Process Safety Center (Texas A&M University)
MMS	Minerals Management Service
MOC	Management of Change
MOU	Memorandum of Understanding (or Memorandum or Agreement)
MSDS	Material Safety Data Sheet
N/A	Not applicable
NB	National Board
NDE	Nondestructive examination
NEP	National Emphasis Program
NDT	Nondestructive testing
NETA	InterNational Electrical Testing Association
NFPA	National Fire Protection Association
NIMS	National Incident Management System
NIST	National Institute of Standards & Technology
OCA	Off-site consequence analysis
OEM	Original equipment manufacturer
OJT	On-the-job training
OMS	Oil movement and storage
OSHA	Occupational Safety and Health Administration
OSHAS	Occupational Health and Safety Assessment Series
OSHRC	Occupational Safety and Health Review Commission
PA	Public address (system)
PANEL	Baker, J.A. et al., *The Report of BP U.S. Refineries Independent Safety Review Panel*, January 2007 (Baker Commission Report).
PDA	Personal digital assistant
PDCA	Plan-Do-Check-Act
PFD	Process flow diagram
PHA	Process hazard analysis
P&ID	Piping and instrument diagram
PMI	Positive material identification
PPE	Personal protective equipment
PRE	Preamble to OSHA's Process Safety Management Standard
PSI	Process safety information
PSK	Process safety knowledge
PSM	Process safety management

PSSR	Pre-start-up safety review
QRA	Quantitative risk analysis
RAGAGEP	Recognized and generally accepted good engineering practice
RBI	Risk-based inspection
RBPS	Risk-based process safety
RC	Responsible Care®
RCA	Root cause analysis
RCM	Reliability centered maintenance
RCMS	Responsible Care Management System
RCRA	Resource Conservation and Recovery Act
RIK	Replacement-in-kind
RMP	Risk management program/risk management plan
RMPP	Risk Management and Prevention Program (California)
RP	Recommended practice
RSPA	Research and Special Projects Administration
SARA	Superfund Amendments and Reauthorization Act
SCBA	Self-contained breathing apparatus
SEMP	Safety and environmental management program
SIF	Safety instrumented function
SIL	Safety integrity level
SIS	Safety instrumented system
SOCMA	Society of Chemical Manufacturers and Affiliates
SOP	Standard operating procedure
SPCC	Spill prevention, countermeasures, and control
SWP	Safe work practice
TCPA	Toxic Catastrophe Prevention Act (New Jersey)
TEMA	Tubular Exchanger Manufacturer's Association
TML	Thickness measurement location
TSD	Treatment, storage, and disposal
TXC	BP Corporation, *Fatal Accident Investigation Report – Isomerization Unit Explosion*, May 2005 (Texas City Refinery)
UKHSE	United Kingdom Health and Safety Executive
UL	Underwriter's Laboratory
UPS	Uninterruptible power supply
USCG	United States Coast Guard
VPP	Voluntary protection program
VCLAR	Verbal clarification of PSM Standard by OSHA
WCLAR	Written clarification of PSM Standard by OSHA
WCS	Worst-case scenario

See the Introduction to Chapters 3–24 for additional acronyms that are used in the element chapters (Chapter 3–24) to define the sources of compliance and related audit criteria.

GLOSSARY

Accident: An incident that results in significant human loss (either injury of death), significant property damage, and/or a significant environmental impact.

Accident prevention pillar: A group of mutually supporting RBPS elements. The RBPS management system is composed of four accident prevention pillars: (1) commit to process safety, (2) understand hazards and risk, (3) manage risk, and (4) learn from experience.

Accountability: The obligation to explain and answer for one's actions that are related to expectations, objectives, and goals. In this context, those that are accountable for PSM activities are answerable to the one person who has the ultimate responsibility for the program. There may be multiple persons accountable for an activity but only one person with the ultimate responsibility. Accordingly, it is a powerful element of an effective process safety management system.

Administrative control: Procedures that will hold human and/or equipment performance within established limits.

Anecdotal: Verbal evidence that is not supported by other, corroborating evidence. For example, the results of an interview with one person are not the basis for issuing a finding.

Apparent cause analysis (ACA): A less formal investigation method that focuses on the immediate causes of a specific incident.

As low as reasonably practicable (ALARP): The concept that efforts to reduce risk should be continued until the incremental sacrifice (in terms of cost, time, effort, or other expenditure of resources) is grossly disproportionate to the incremental risk reduction achieved. The term *as low as reasonably achievable (ALARA)* is often used synonymously.

Asset integrity: A PSM program element involving work activities that help ensure that equipment is properly designed, installed in accordance with specifications, and remains fit for purpose over its life cycle. Also asset integrity and reliability.

Audit: A systematic, independent review to verify conformance with prescribed requirements using a well-defined review process to ensure consistency and to allow the auditor to reach defensible conclusions.

By exception: The term "by exception" means that only information that fits a certain definition is documented and not all of the information that was generated by the activity. For example, in a HIRA, this most commonly happens when only those hazard scenarios that resulted in a recommendation(s) are documented and

no others. In Asset Integrity, only those ITPM tasks that result in an out-of-specification result are documented.

Catastrophic release: An uncontrolled loss of containment of toxic, reactive, or flammable materials from a process that has the potential for causing onsite or offsite acute health effects, significant environmental effects (e.g., compromise of a public drinking water supply), or significant on-site or off-site property damage.

CCPA: Canadian Chemical Producer's Association, *Major Industrial Accidents Council of Canada (MIACC) Self Assessment Tool*, September 2001. PSM Guide/HISAT Revision Project: Version 070820 prepared by the PSM committee of CCPA (rights maintained by CSChE).

Checklist: A list of items requiring verification of completion; typically, a procedure format in which each critical step is marked off (or otherwise acknowledged/verified) as it is performed. Checklists are often appended to procedures that provide a more detailed description of each step, including information regarding hazards, and a more complete description of the controls associated with the hazards. Checklists are also used in conjunction with formal hazard evaluation techniques to ensure thoroughness.

Code: Written requirements that affect a facility and/or the process safety requirements that apply to a facility. Codes contain requirements that apply to the design and implementation of management systems, design and operation of process equipment, or similar activities. The difference between a code and a standard is that codes have become part of a law or regulation, and therefore their requirements become mandatory within the jurisdictions that have adopted the code requirements in their laws or regulations. This usually occurs at the state level, but may also occur in local or federal laws or regulations.

Competency: A PSM program element associated with efforts to maintain, improve, and broaden knowledge and expertise.

Conduct of operations: The execution of operational and management tasks in a deliberate and structured manner that attempts to institutionalize the pursuit of excellence in the performance of every task and minimize variations in performance.

Confirmation: A special audit term referring to the substantiation of the existence or condition of something. A confirmation often takes the form of a written request and acknowledgement from independent third parties, but it may also be obtained orally or through observation.

Consequence: The direct, undesirable result of an incident sequence usually involving a fire, explosion, or release of toxic material. Consequence descriptions may be qualitative or quantitative estimates of the effects of an accident in terms of factors such as health impacts, economic loss, and environmental damage.

Consistency: Continued uniformity, during a period or from one period to another.

Continuous improvement: Doing better as a result of regular, consistent efforts rather than episodic or step-wise changes, producing tangible positive improvements either in performance, efficiency, or both. Continuous improvement efforts usually involve a formal evaluation of the status of an activity or management system, along

with a comparison to an achievement goal. These evaluation and comparison activities occur much more frequently than formal audits.

Contractor management: A system of controls to ensure that contracted services support (1) safe facility operations and (2) the company's process safety and personal safety performance goals. It includes the selection, acquisition, use, and monitoring of contracted services.

Controls: Engineered mechanisms and administrative policies/procedures implemented to prevent or mitigate incidents.

Core value: A value that has been promoted to an ethical imperative, accompanied with a strong individual and group intolerance for poor performance or violations of standards for activities that impact the core value.

Decommissioning: Completely de-inventorying all materials from a process unit and permanently removing the unit from service. Decommissioning normally involves permanently disconnecting the unit from other processes and utilities, and is often followed by removal of the process piping, equipment, and support structures.

Determine: To conclude; to reach an opinion consequent to the observation of the fit of sample data within the limit, range, or area associated with substantial conformance, accuracy, or other predetermined standard; to obtain firsthand knowledge of.

Effectiveness: The combination of process safety management performance and process safety management efficiency. An effective process safety management program produces the required work products of sufficient quality while consuming the minimum amount of resources.

Efficacy: See Effectiveness.

Element: Basic division in a process safety management system that correlates to the type of work that must be done (e.g., MOC).

Emergency management: A PSM program element involving work activities to plan for and respond to emergencies.

Evaluate: To reach a conclusion as to significance, worth, effectiveness, or usefulness.

Exception: A finding that is a deviation from a standard.

Facility: The physical location where the management system activity is performed. In early life-cycle stages, a facility may be the company's central research laboratory or the engineering offices of a technology vendor. In later stages, the facility may be a typical chemical plant, storage terminal, distribution center, or corporate office. Site is used synonymously with facility when describing to RMP audit criteria.

Failure modes and effects analysis (FMEA): A systematic, tabular method for evaluating and documenting the causes and effects of known types of component failures.

Fault tree: A logic model that graphically portrays the combinations of failures that can lead to a specific main failure or accident of interest.

Finding: A conclusion reached by the audit team based on data collected and analyzed in response to a specific audit question which indicates a need for improvement in the PSM program design or implementation. Findings are sometimes also referred to exceptions. Although strictly speaking a finding can be a positive or negative conclusion, common custom and terminology in auditing is to refer to the deficiencies identified as the "findings." Findings include both the basis for the conclusion, i.e., an audit question or criteria, as well as the explanatory conclusion and the evidence that substantiates the conclusion.

Frequency: The number of occurrences per unit time at which observed events happen or are predicted to happen.

GIP: Good industry practice in PSM (i.e., a best or common practice that a facility or company has found to be a useful addition to its PSM program, or a useful but nonmandatory solution to a PSM issue.

Hazard: Chemical or physical conditions that have the potential for causing harm to people, property, or the environment. In these *Guidelines*, hazard refers to the first risk attribute: What can go wrong?

Hazard analysis: See Hazard identification and risk analysis.

Hazard and operability (HAZOP) study: A systematic method in which process hazards and potential operating problems are identified using a series of guidewords to investigate process deviations.

Hazard identification: The recognition of material, system, process, and plant characteristics that can produce undesirable consequences through the occurrence of an accident.

Hazard identification and risk analysis (HIRA): A collective term that encompasses all activities involved in identifying hazards and evaluating risk at facilities, throughout their life cycle, to make certain that risks to employees, the public, or the environment are consistently controlled within the organization's risk tolerance.

Hazardous chemical: A material that is toxic, reactive, or flammable and is capable of causing a process safety incident if released. Also Hazardous material.

Highly hazardous chemical: A material that is toxic, reactive, or flammable and is capable of causing a process safety incident if released. These materials are included in OSHA's PSM Standard, 29 CFR §1910.119.

Human factors: A discipline concerned with designing machines, operations, and work environments to match human capabilities, limitations, and needs. Among human factors specialists, this general term includes any technical work (e.g., engineering, procedure writing, worker training, worker selection) related to the person in man-machine systems.

Implementation: Completion of an action plan associated with the outcome of the process of resolving audit findings, incident investigation team recommendations, risk analysis team recommendations, and so forth. Also, the establishment or execution of PSM program element work activities.

Incident: An unplanned sequence of events with the potential for undesirable consequences.

Incident investigation: A systematic approach for determining the causes of an incident and developing recommendations that address the causes to help prevent or mitigate future incidents. See also Root cause analysis and Apparent cause analysis.

Independent protection layer (IPL): A device, system, or action that is capable of preventing a postulated accident sequence from proceeding to a defined, undesirable endpoint. An IPL is independent of the event that initiated the accident sequence and independent of any other IPLs. IPLs are normally identified during layer of protection analyses.

Inherently safer: A condition in which the hazards associated with the materials and operations used in the process have been reduced or eliminated, and this reduction or elimination is permanent and inseparable from the process. Inherently safer technology (IST) is also used interchangeably with inherently safety in the book.

Inspection: A work activity designed to determine if ongoing work activities associated with operating and maintaining a facility comply with an established standard. Inspections normally provide immediate feedback to the persons in charge of the ongoing activities, but normally do not examine the management systems that help ensure that policies and procedures are followed.

Inspection, testing, and preventive maintenance (ITPM): Scheduled proactive maintenance activities intended to (1) assess the current condition and/or rate of degradation of equipment, (2) test the operation/functionality of equipment, and/or (3) prevent equipment failure by restoring equipment condition.

Internal controls: The various engineering and managerial means, both formal and informal, established within an organization to help the organization direct and regulate its activities in order to achieve desired results; also refers to the general methodology by which specific management processes are carried on within an organization. The requirement for management systems and their formal evaluation during an audit are not currently compliance requirements. The evaluation of the adequacy of the internal controls is accomplished using some of the related audit criteria.

Interview: Questioning, both formally and informally, facility personnel or other individuals in order to obtain an understanding of the plant's operations and performance.

ITPM program: A program that develops, maintains, monitors, and manages inspection, testing, and preventive maintenance activities.

Internal controls: The various engineering and managerial methods, both formal and informal, established within an organization to help it direct and regulate its activities in order to achieve desired results. This term also refers to the general methodology by which specific management processes are carried on within an organization.

Knowledge, skills, and abilities (KSAs): Knowledge is related to information, which is often associated with policies, procedures, and other rule-based facts. Skills are related to the ability to perform a well-defined task with little or no

guidance or thought. Abilities concern the quality of decision making and execution when faced with an ill-defined task (e.g., applying knowledge to troubleshooting).

Lagging indicator: Outcome-oriented metrics, such as incident rates or other measures of past performance.

Layer of protection analysis (LOPA): A process of evaluating the effectiveness of independent protection layer(s) in reducing the likelihood of an undesired event.

Leading indicator: Process-oriented metrics, such as the degree of implementation or conformance to policies and procedures, that support the PSM program management system and has the capability of predicting performance.

Level of acceptable practice: Good, successful, common, or best practices in PSM that have evolved, either through common and successful usage, interpretation by regulators, or in clear and measurable reductions in process safety risk, into informal criteria that are used by industry and by regulators to define acceptable practices in PSM.

Life cycle: The stages that a physical process or a management system goes through as it proceeds from birth to death. These stages include conception, design, deployment, acquisition, operation, maintenance, decommissioning, and disposal.

Likelihood: The expected frequency of an event's occurrence, and the probability of that frequency.

Limiting conditions for operation: Specifications for critical systems that must be operational and critical resources that must be available to start a process or continue normal operation. Critical systems often include fire protection, flares, scrubbers, emergency cooling, and thermal oxidizers; critical resources normally involve staffing levels for operations and other critical functions.

Management review: A PSM program element that provides for the routine evaluation of other PSM program management systems/elements with the objective of determining if the element under review is performing as intended and producing the desired results as efficiently as possible. It is an ongoing "due diligence" review by management that fills the gap between day-to-day work activities and periodic formal audits.

Management system: A formally established set of activities designed to produce specific results in a consistent manner on a sustainable basis.

Metrics: Leading and lagging measures of process safety management efficiency or performance. Metrics include predictive indicators, such as the number of improperly performed line-breaking activities during the reporting period, and outcome-oriented indicators, such as the number of incidents during the reporting period.

National Emphasis Program: The NEP is for the refinery sector (OSHA Directive CPL 03-00-004) and extended to the chemical sector (OSHA Directive 09-06 (CPL 02)). The NEP is an inspection/enforcement program designed by OSHA to more thoroughly examine the implementation of PSM programs in the refining and chemical industries.

Near-miss incident: An unplanned sequence of events that could have caused harm or loss if conditions were different or if the events were allowed to progress, but actually did not. Also near miss.

Normalization of deviance: A gradual erosion of standards of performance as a result of increased tolerance of nonconformance. Also normalization of deviation.

Objectivity: Freedom from bias.

Observation: The noting and recording of information to support findings. Also field observation.

Operating mode: A phase of operation during the operation and maintenance stages of the life cycle of a facility. Operating modes include start-up, normal operation, shutdown, product transitions, equipment cleaning and decontamination, maintenance, and similar activities.

Operating limits: The values or ranges of values within which the process parameters normally should be maintained when operating. These values are usually associated with preserving product quality or operating the process efficiently; however, they may also incorporate the safe upper and lower limits of the process, or other important limits.

Operational readiness: A PSM program element associated with efforts to ensure that a process is ready for start-up/restart. This element applies to a variety of restart situations, ranging from restart after a brief maintenance outage to restart of a process that has been mothballed for several years.

Operator: An individual responsible for monitoring, controlling, and performing tasks as necessary to accomplish the productive activities of a system. Operator is also used in a generic sense to include people who perform a wide range of tasks (e.g., reading, calibration, incidental maintenance, manage loading/unloading, and storage of hazardous materials).

OSHA Process Safety Management, 29 CFR §1910.119 (OSHA PSM): A U.S. regulatory standard that requires use of a 14-element management system to help prevent or mitigate the effects of catastrophic releases of chemicals or energy from processes covered by the regulation.

Panel: Baker, J.A. et al., *The Report of BP U.S. Refineries Independent Safety Review Panel*, January 2007 (Baker Commission Report).

Performance: A measure of the quality or utility of PSM program work products and work activities.

Performance assurance: A formal management system that requires workers to demonstrate that they understand a training module and can apply the training in practical situations. Performance assurance is normally an ongoing process to (1) ensure that workers meet performance standards and maintain proficiency throughout their tenure in a position and (2) help identify tasks for which additional training is required.

Performance-based requirement: A requirement that defines necessary results without defining the specific means to accomplish them—the "what to do," but not "how to do it." The means for producing the desired results is left up to the

discretion of the facility based on an evaluation of its needs and conditions, and on industry practices. For example, the requirement to implement a MOC system that considers the impact of safety and health as part of the review/approval process, and to prevent changes that pose an unacceptable risk to workers, is a performance-based requirement. The implementer must define the process to identify and review risk associated with changes, determine what level of risk is tolerable, and evaluate the risk in sufficient detail to demonstrate that they have met a level of acceptable practice, which in this case may be to provide a safe work environment. (See also Prescriptive requirement, which differs from a performance-based requirement in that a prescriptive requirement states how the activity should be performed.)

Performance indicators: See Metrics.

Pillar: See Accident prevention pillar.

Prescriptive requirement: A requirement that explicitly states both "what to do" and "how to do it." For example, the specifications for a full body harness and the requirement that it be used when working at a certain height or within a specified distance from the edge of a roof are prescriptive requirements. (See also Performance-based requirement, which differs from a prescriptive requirement in that a performance-based requirement does not state how the activity should be performed.)

Procedures: Written, step-by-step instructions and associated information (cautions, notes, warnings) that describe how to safely perform a task.

Process safety: The protection of people and property from episodic and catastrophic incidents that may result from unplanned or unexpected deviations in process conditions.

Process safety competency: See Competency.

Process safety culture: The combination of group values and behaviors that determines the manner in which process safety is managed. A sound process safety culture refers to attitudes and behaviors that support the goal of safer process operations.

Process safety incident/event: An event that is potentially catastrophic, i.e., an event involving the release/loss of containment of hazardous materials that can result in large-scale health and environmental consequences.

Process knowledge management: A PSM program element that includes work activities to gather, organize, maintain, and provide information to other PSM program elements. Process safety knowledge primarily consists of written documents such as hazard information, process technology information, and equipment-specific information. Process safety knowledge is the product of this PSM element.

Process safety management (PSM): A management system that is focused on prevention of, preparedness for, mitigation of, response to, and restoration from catastrophic releases of chemicals or energy from a process associated with a facility. In this book, PSM does not refer exclusively to a process safety management program developed pursuant to or in accordance with OSHA's PSM Standard, 29 CFR §1910.119, but is used as a more general term to describe any

process safety management program that has defined requirements or guidance for its format, content, and implementation, whether it is required by law of regulation or is a voluntary program.

Process safety management systems: Comprehensive sets of policies, procedures, and practices designed to ensure that barriers to episodic incidents are in place, in use, and effective.

Protocol: A document that organizes audit procedures into a general sequence of audit steps and describes the actions to be taken by the auditor.

PSM audit: An activity to determine and status and quality of a PSM program. This term is not used to describe an audit performed exclusively in response to OSHA's PSM Standard, but to an audit of any PSM program.

Quantitative risk analysis (QRA): The systematic development of numerical estimates of the expected frequency and/or consequence of potential accidents associated with a facility or operation based on engineering evaluation and mathematical techniques.

Readiness review: A work activity that occurs prior to initial start-up or restarting a process unit to verify that the condition of process equipment and safety systems, the status of limiting conditions for operations, and in some cases, the training and qualification status of personnel conform to predefined conditions. Also Operational readiness review and pre-start-up readiness review.

Recognized and generally accepted good engineering practice (RAGAGEP): Legal, consensus, or recommended practices with respect to design, construction, operations, and maintenance of equipment. RAGAGEPs can take the form of law or regulation; consensus codes and standards, recommended practices, and other guidance published and maintained by industry trade and professional organizations; manufacturer's recommendations for design, installation, operations, and maintenance; or guidance derived from the operating history of the equipment within a given facility or the industry as a whole. Most of the RAGAGEPs used in the chemical/processing industry are consensus industry codes, standards, and recommended practices. These codes and standards define the level of acceptable practice within the industry for various technical and administrative issues. In addition, they are periodically updated to reflect new information from all stakeholders (equipment designers, manufacturers, users, etc.). In some cases, regulators have also directly adopted these RAGAGEPs, and in some cases they have been embedded in state or municipal law.

Related criteria: Audit criteria derived from good, successful, common, or best practices in PSM that are not considered compliance issues, but supplement and improve a PSM program that meets the minimum compliance requirements. The evaluation of PSM management systems and the internal controls they impose are performed using related criteria.

Replacement-in-kind (RIK): An item (equipment, chemical, procedure, etc.) that meets the design specification of the item it is replacing. This can be an identical replacement or any other alternative specifically provided for in the design

specification, as long as the alternative does not in any way adversely affect the use of the item or associated items.

Representative unit: A unit part of a unit that is covered by the PSM program that is being audited. When the potential scope of the audit would include a large number of units or equipment, focus units are sometimes used to help the auditors select records and documents for review, and people to interview, so that these inputs are sampled from a small number of selected units which are then considered typical of all covered units.

Resolution: Management's determination of what needs to be done in response to an audit finding (and/or associated recommendation), incident investigation team recommendation, risk analysis team recommendation, and so forth. During the resolution step, management accepts, rejects for cause, or modifies each recommendation. If the recommendation is accepted, an action plan for its implementation will typically be identified as part of the resolution. (See Implementation.)

Responsibility: The single person who has been assigned and has accepted the ultimate accountability for the development and or implementation a program, its separate activities, as well as its success or failure. There can be only one person with the ultimate responsibility for something. Although "accountability" enters into this definition, that term is used separately in this book.

Resources: The labor effort, capital and operating costs, and other inputs that must be provided to execute work activities and produce work products.

Review: To study critically an operation, procedure, condition, event, or series of transactions.

Risk: The combination of three attributes: what can go wrong, how bad could it be, and how often might it happen.

Risk analysis: A study or review of risk associated with a set of activities or list of potential accident scenarios. A risk analysis normally considers all three risk attributes. A risk analysis can provide qualitative or quantitative results.

Risk-based: The adjective "risk-based" is used to portray one or more risk attributes of a process, activity, or facility. In this context, considering any one of the three risk questions can be viewed as a risk-based activity. For example, when considering the hazards of a substance or a process in deciding how much rigor to build into an operating procedure, the term "risk-based design" is used rather than hazard-based design, even though understanding the hazard attributes was the primary determinant in the design of the procedure. So, for simplicity, rather than use the independent terms "hazard-based," "consequence-based," or "frequency-based," the single term "risk-based" is used to mean any one or a combination of these terms.

Risk-based process safety (RBPS): The CCPS's process safety management system approach that uses risk-based strategies and implementation tactics commensurate with the risk-based need for process safety activities, availability of resources, and existing process safety culture to design, correct, and improve process safety management activities. RBPS recognizes that all hazards and risks are not equal;