



GUIDELINES FOR

**PROCESS SAFETY
DURING THE
TRANSIENT
OPERATING MODE**

**MANAGING RISKS DURING PROCESS
START-UPS AND SHUT-DOWNS**



Guidelines for Process Safety

During the Transient Operating Mode:

Managing Risks during Process Start-ups and Shut-downs

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Center for Chemical Process Safety
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Acronyms and Abbreviations

AIChE	American Institute of Chemical Engineers
C	Consequence (<i>see Equation 10.1</i>)
CCPS	Center for Chemical Process Safety
ERP	Emergency Response Plan
ERT	Emergency Response Team
ESD	Emergency Shutdown Device
ESS	Emergency Shutdown System
F	Frequency (<i>see Equation 10.1</i>)
HAZOP	Hazards and Operability Study
HIRA	Hazards Identification and Risk Analysis
ITPM	Inspection, Testing, and Preventive Maintenance program
LOPA	Layer of Protection Analysis
LL	Lesson Learned
LS	Lesson Strength
LTI	Lost Time Injury
MOC	Management of Change
MTC	Medical Treatment Case
OD	Operational Discipline (<i>see Equation 10.1</i>)
ORR	Operational Readiness Review
PDCA	Plan, Do, Check, Act
PHA	Process Hazards Analysis
PPE	Personal Protective Equipment
PSSR	Pre-Startup Safety Review
R	Risk (<i>see Equation 10.1</i>)
RBPS	CCPS Risk Based Process Safety

SIMOPS	Simultaneous Operations
SIS	Safety Instrumented System
SWP	Safe Work Practice
US CSB	United States Chemical Safety and Hazard Investigation Board

Glossary

This Glossary contains some of the common terms in this guideline and some of the relevant process safety-related terms from the CCPS Process Safety Glossary. Refer to Table 2.1 for the glossary terms specific to normal, abnormal, and emergency operations, and to Table 2.2 for those specific to the transient operating modes. The terms in this guideline are current at the time of publication; refer to the CCPS website for updates to the CCPS Process Safety Glossary.

Term	Definition
Conduct of Operations (COO)	An element in the CCPS RBPS model. The embodiment of an organization's values and principles in management systems that are developed, implemented, and maintained to (1) structure operational tasks in a manner consistent with the organization's risk tolerance, (2) ensure that every task is performed deliberately and correctly, and (3) minimize variations in performance. See Operational Discipline.
Consequence (C)	The undesirable result of the impact of a loss event, usually measured in health and safety effects, environmental impacts, loss of property, and business interruption costs. See Equation 10.1.
Deviation	A process condition outside of established design limits, safe operating limits, or standard operating procedures.
Emergency Shutdown Device (ESD)	A device that is designed to shut-down the system to a safe condition on command from the Emergency Shutdown System.

Term	Definition
Emergency Shutdown System (ESS)	The safety system that overrides the action of the basic control system when predetermined conditions are violated.
Frequency (F)	Number of occurrences of an event per unit time (e.g., 1 event in 1000 yr. = 1×10^{-3} events/yr.). Interchangeable with “likelihood”. See Equation 10.1.
Hazards 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.
Inspection, Testing, and Preventive Maintenance (ITPM) Program	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.
Loss event	Point in time in an abnormal situation when an irreversible physical event occurs that has the potential for loss and harm impacts.
Operational Discipline (OD)	The performance of all tasks correctly every time. <i>Note:</i> OD is the execution of the CCPS RBPS Conduct of Operations (COO) element by

Term	Definition
	individuals within the organization. See effect on Risk in Equation 10.1.
Outage	See Turnaround.
Pickling	A metal surface treatment used to remove impurities, such as inorganic contaminants, rust or scale from ferrous metals, copper, precious metals and aluminum alloys. A solution called pickle liquor, which usually contains acid, is used to remove the surface impurities.
Plan, Do, Check, Act (PDCA)	A four-step process for quality improvement. In the first step (Plan), a way to bring about improvement is developed. In the second step (Do), the plan is carried out. In the third step (Check), what was predicted is compared to what was observed in the previous step. In the last step (Adjust), plans are revised to eliminate performance gaps.
Risk	A measure of human injury, environmental damage, or economic loss in terms of both the incident likelihood (frequency) and the magnitude of the loss or injury. <i>Note:</i> A simplified version of this relationship expresses risk as the product of the frequency and the consequence's impact (i.e., Risk = Frequency x Consequence). See Equation 10.1.

Term	Definition
Risk Based Process Safety (RBPS)	The Center for Chemical Process Safety's (CCPS) process safety management system approach that uses risk-based strategies and implementation tactics that are commensurate with the Risk Based Process Safety (no hyphen) need for process safety activities, availability of resources, and existing process safety culture to design, correct, and improve process safety management activities.
Risk matrix	A tabular approach for presenting risk tolerance criteria, typically involving graduated scales of incident likelihood on the Y-axis and incident consequences on the X-Axis. Each cell in the table (at intersecting values of incident likelihood and incident consequences) represents a particular level of risk.
Safety Instrumented System (SIS)	A separate and independent combination of sensors, logic solvers, final elements, and support systems that are designed and managed to achieve a specified safety integrity level. Note: A SIS may implement one or more Safety Instrumented Functions (SIFs).

Term	Definition
Shutdown (S/D)	A process by which an operating plant or system is brought to a safe and non-operating mode. <i>Note for this guideline:</i> Equivalent to the multiple shut-down transient operating modes discussed in this book (Table 2.2).
Significant loss event	Point in time in an abnormal situation when an irreversible physical event occurs that causes loss and harm impacts. <i>Note:</i> Companies can specify “significant” depending on the relative impact to people, the environment, property, and business interruption—their “risk tolerance.” See Risk matrix.
Standby mode	Hardware operation that is normally not running but should be ready to run, e.g., an emergency diesel generator. <i>Note for this guideline:</i> When troubleshooting equipment during an abnormal situation, specific equipment may be placed in a temporary “standby” or “warm circulation” mode while the troubleshooting efforts are underway.
Turnaround	A scheduled shutdown period when planned inspection, testing, and preventive maintenance (ITPM), as well as corrective maintenance such as modifications, replacements, or repairs is performed. <i>Note:</i> Often referred to as a shutdown (Per this guideline: no hyphen) or an outage.

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Dedication

This guideline is dedicated to those who have been injured or lost their lives, and their families, as a result of incidents that occurred during transition times in the industries handling hazardous materials and energies. Hazards and risk management approaches continue to improve facilities based on the learnings from these incidents. Since there is a better understanding of some of the human performance-related issues today, improved engineering and administrative controls have been established to help prevent these type of incidents from occurring again. This guideline puts forth a framework that applies the Risk Based Process Safety (RBPS) principals to activities specifically associated with the transient operating mode. It is the hope of the authors that the risk reduction approaches provided in this guideline can be integrated and implemented within the existing process safety and risk management systems in organizations striving toward world-class process safety performance.

"Do not let the world's adversity stifle your enthusiasm, nor blind your vision. The struggle towards excellence should ever be conducted on the high plains of self-confidence, a sense of purpose, and positive thought. Go forth with a desire to accomplish...with a desire to contribute to our society."

Ronald E. McNair, 1950 - 1986

NASA Astronaut - Space Shuttle Challenger