
Graduate Certificate in Human Factors in Process Safety Management

Human Error and Error Management

Human error is a critical concept in the field of Human Factors in Process Safety Management. Understanding the types of human errors, their causes, and how to effectively manage them is essential for ensuring the safety and reliability of processes in various industries.

Key Terms and Vocabulary:

- **Human Error**: Human error refers to deviations from the intended actions or plans of individuals that result in undesirable outcomes. It is a common occurrence in complex systems and can lead to accidents or incidents if not properly managed.
- **Error Management**: Error management involves strategies and practices aimed at reducing the likelihood and impact of human errors in various processes. It focuses on identifying, analyzing, and mitigating errors to improve overall system safety and performance.
- **Cognitive Bias**: Cognitive bias refers to systematic patterns of deviation from norm or rationality in judgment, whereby inferences about other people and situations may be drawn in an illogical fashion.
- **Situation Awareness**: Situation awareness is the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future.
- **Hazard Identification**: Hazard identification is the process of recognizing potential hazards in a system or process that could lead to accidents or incidents. It is a crucial step in proactive error management.
- **Risk Assessment**: Risk assessment is the process of evaluating potential risks associated with identified hazards. It involves analyzing the likelihood and consequences of adverse events to determine the level of risk.
- **Root Cause Analysis**: Root cause analysis is a methodical process used to identify the underlying causes of problems or incidents. It aims to address the fundamental issues that lead to errors rather than just their symptoms.
- **Human Reliability**: Human reliability refers to the likelihood of individuals performing tasks accurately and consistently without errors. It is a key factor in determining the overall reliability of a system.
- **Resilience Engineering**: Resilience engineering is an approach that focuses on enhancing the ability of systems to adapt to changing conditions and recover from errors or failures. It emphasizes the importance of learning from incidents to improve system performance.
- **Safety Culture**: Safety culture refers to the shared values, attitudes, and behaviors related to safety within an organization. A strong safety culture promotes open communication, proactive error reporting,

and continuous improvement in safety practices.

- **Workload Management**: Workload management involves balancing the demands of tasks with the capabilities of individuals to prevent overload or underload situations that can lead to errors. It includes strategies for prioritizing tasks, allocating resources effectively, and optimizing work processes.
- **Human Factors Engineering**: Human factors engineering is a multidisciplinary field that focuses on designing systems, products, and environments to optimize human performance and reduce the likelihood of errors. It considers human capabilities and limitations to enhance safety and efficiency.
- **Error Reporting**: Error reporting is the process of documenting and communicating errors or near misses within an organization. It is essential for identifying trends, analyzing root causes, and implementing corrective actions to prevent similar errors in the future.
- **Training and Competence**: Training and competence refer to the knowledge, skills, and abilities required for individuals to perform their tasks effectively and safely. Proper training programs and competency assessments are essential for error prevention and management.
- **Situational Awareness**: Situational awareness is the perception of environmental elements and events with respect to time or space, the comprehension of their meaning, and the projection of their status in the near future.
- **Fatigue Management**: Fatigue management involves strategies for preventing and mitigating the effects of fatigue on human performance. It includes policies for scheduling rest periods, managing work hours, and promoting healthy lifestyle practices to reduce the risk of errors due to fatigue.
- **Communication**: Communication is the process of exchanging information, ideas, or instructions between individuals or groups. Effective communication is essential for error prevention and management, as misunderstandings or misinterpretations can lead to errors.
- **Decision Making**: Decision making is the process of selecting a course of action from multiple alternatives based on available information and preferences. Understanding decision-making biases and heuristics is important for error management in complex situations.
- **Teamwork**: Teamwork refers to the collaborative efforts of individuals working together to achieve common goals. Effective teamwork is crucial for error management, as clear roles, responsibilities, and communication are essential for preventing errors and improving safety.
- **Incident Investigation**: Incident investigation is the process of analyzing accidents, near misses, or other adverse events to identify contributing factors and develop recommendations for preventing similar incidents in the future. It involves gathering data, interviewing witnesses, and examining physical evidence to understand the causes of errors.
- **Human Error Taxonomy**: Human error taxonomy is a classification system used to categorize different types of human errors based on their characteristics and contributing factors. It helps organizations to identify patterns, trends, and common causes of errors for targeted error management strategies.

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- **Performance Shaping Factors**: Performance shaping factors are external influences that can affect human performance and increase the likelihood of errors. These factors include environmental conditions, equipment design, organizational culture, and individual characteristics that can impact decision-making and task execution.
 - **Automation**: Automation refers to the use of technology to perform tasks or processes with minimal human intervention. While automation can reduce the risk of human errors, it can also introduce new types of errors related to system complexity, complacency, or reliance on technology.
 - **Normalization of Deviance**: Normalization of deviance refers to the gradual acceptance of unsafe practices or deviations from standard procedures as normal behavior. This phenomenon can lead to complacency, risk-taking, and a tolerance for errors that may result in accidents or incidents.
 - **Safety Critical Tasks**: Safety critical tasks are activities that have a direct impact on the safety of individuals, processes, or systems. Managing human errors in safety critical tasks is essential for preventing catastrophic events and ensuring the reliability of safety-critical systems.
 - **Barrier Management**: Barrier management involves implementing physical, procedural, or administrative controls to prevent or mitigate the consequences of errors. Barriers are designed to detect errors, interrupt error chains, or provide safeguards to minimize the impact of errors on system performance.
 - **Resilience**: Resilience is the ability of a system to withstand disturbances, adapt to changing conditions, and recover from errors or failures. Building resilience in organizations involves promoting a culture of learning, flexibility, and adaptability to improve system performance under varying conditions.
 - **Safety Instrumented Systems**: Safety instrumented systems are designed to automatically detect hazardous conditions, initiate safety actions, and prevent accidents or incidents in industrial processes. These systems play a critical role in managing human errors and ensuring the safety of workers and the environment.
 - **Human Error Probability**: Human error probability is a quantitative measure of the likelihood of individuals making errors while performing specific tasks. It is used in risk assessments to estimate the potential impact of human errors on system reliability and safety.
 - **Safety Critical Communication**: Safety critical communication refers to the exchange of information that is essential for ensuring the safety of individuals, processes, or systems. Clear, accurate, and timely communication is vital for error prevention and management in safety-critical environments.
 - **Safety Management Systems**: Safety management systems are comprehensive frameworks that organizations use to manage safety risks, comply with regulations, and continuously improve safety performance. These systems integrate policies, procedures, processes, and resources to promote a culture of safety and prevent errors.
 - **Human Error Reduction Techniques**: Human error reduction techniques are strategies and tools used

to minimize the likelihood and impact of human errors in various processes. These techniques include error-proofing, automation, training, cognitive aids, checklists, and other interventions aimed at improving human performance and system reliability.

- **Safety Critical Decision Making**: Safety critical decision making involves making choices that have a direct impact on the safety of individuals, processes, or systems. It requires careful consideration of risks, uncertainties, and potential consequences to avoid errors and ensure safe outcomes.
- **Safety Culture Assessment**: Safety culture assessment is the process of evaluating an organization's values, attitudes, and behaviors related to safety. It involves surveys, interviews, observations, and other methods to assess the effectiveness of safety practices, communication, and leadership in promoting error management and safety.
- **Human Error Analysis**: Human error analysis is a systematic process of investigating human errors to identify their causes, contributing factors, and implications for system performance. It helps organizations understand the root causes of errors and develop targeted interventions to prevent similar incidents in the future.
- **Safety Critical Task Analysis**: Safety critical task analysis is a method for identifying, evaluating, and managing risks associated with tasks that have a direct impact on safety. It involves breaking down tasks into steps, identifying potential hazards, and implementing controls to prevent errors and reduce the likelihood of accidents or incidents.
- **Safety Critical Systems Engineering**: Safety critical systems engineering is a discipline that focuses on designing, implementing, and managing systems with a high level of safety and reliability. It involves applying engineering principles, risk assessments, and human factors considerations to develop systems that can withstand errors and failures while ensuring the safety of workers and the public.
- **Safety Performance Indicators**: Safety performance indicators are metrics used to monitor and evaluate an organization's safety performance. These indicators measure the frequency and severity of incidents, near misses, injuries, and other safety-related events to assess the effectiveness of error management strategies and improve safety practices.
- **Safety Critical Competencies**: Safety critical competencies are the knowledge, skills, and attributes required for individuals to perform safety critical tasks effectively and safely. These competencies include technical expertise, decision-making abilities, communication skills, situational awareness, and resilience to manage errors and ensure safe outcomes in high-risk environments.
- **Safety Critical Procedures**: Safety critical procedures are documented instructions that outline the steps, requirements, and precautions for performing safety critical tasks. These procedures provide guidance to individuals on how to execute tasks safely, identify potential hazards, and respond to emergencies to prevent errors and ensure the reliability of safety critical systems.
- **Human Error Prevention**: Human error prevention involves proactive measures to reduce the likelihood of human errors in various processes. It includes designing systems, tasks, and environments to support

error-free performance, providing training and feedback to enhance human capabilities, and implementing error detection and correction mechanisms to minimize the impact of errors on system safety and reliability.

- **Safety Critical Equipment**: Safety critical equipment refers to devices, systems, or components that are essential for maintaining the safety and integrity of industrial processes. These equipment include safety valves, alarms, sensors, interlocks, emergency shutdown systems, and other safeguards that prevent accidents, protect workers, and mitigate the consequences of errors in safety critical environments.
- **Safety Critical Software**: Safety critical software is computer programs or applications that control safety critical functions in industrial processes. These software systems are designed to detect hazards, monitor system performance, implement safety measures, and prevent errors that could lead to accidents or incidents. Ensuring the reliability and security of safety critical software is essential for managing human errors and maintaining the safety of critical systems.
- **Safety Critical Monitoring**: Safety critical monitoring involves continuous surveillance of safety critical systems, processes, and environments to detect deviations, anomalies, or errors that could compromise safety. Monitoring activities include real-time data analysis, performance assessments, alarm management, and other measures to ensure the effectiveness of safety controls, prevent errors, and respond to emergencies in a timely manner.
- **Safety Critical Audits**: Safety critical audits are systematic evaluations of safety critical systems, procedures, and practices to assess compliance with safety standards, identify deficiencies, and recommend improvements. These audits help organizations verify the effectiveness of error management strategies, promote a culture of safety, and enhance the reliability of safety critical systems by addressing potential risks and vulnerabilities.
- **Safety Critical Reviews**: Safety critical reviews are formal assessments of safety critical systems, processes, or decisions to evaluate their effectiveness, identify potential errors, and propose corrective actions. Reviews involve expert analysis, peer evaluations, and stakeholder feedback to ensure that safety critical components meet performance requirements, comply with regulations, and support error-free operations in high-risk environments.
- **Safety Critical Inspections**: Safety critical inspections are systematic examinations of safety critical equipment, facilities, or procedures to verify their integrity, functionality, and compliance with safety regulations. Inspections involve visual assessments, testing, maintenance checks, and other activities to detect defects, malfunctions, or errors that could compromise safety and reliability. Regular inspections are essential for preventing equipment failures, identifying potential hazards, and maintaining the effectiveness of safety critical systems in industrial settings.
- **Safety Critical Documentation**: Safety critical documentation includes policies, procedures, manuals, records, and other written materials that provide guidance on safety critical tasks, requirements, and responsibilities. Documentation ensures that individuals have access to accurate information, instructions, and references to perform tasks safely, comply with regulations, and support error management practices in safety critical environments. Clear, concise, and up-to-date documentation is essential for promoting a

culture of safety, enhancing communication, and preventing errors in high-risk settings.

- **Safety Critical Training**: Safety critical training programs are designed to educate individuals on safety critical tasks, procedures, regulations, and best practices to enhance their knowledge, skills, and competencies for error-free performance. Training includes classroom instruction, hands-on exercises, simulations, drills, and other learning activities to prepare individuals for emergencies, prevent errors, and promote safety in high-risk environments. Effective training programs are essential for ensuring that workers have the necessary capabilities to manage risks, respond to hazards, and maintain the reliability of safety critical systems in industrial settings.

- **Safety Critical Reporting**: Safety critical reporting involves documenting and communicating safety-related incidents, near misses, hazards, and other events that could impact the safety and reliability of critical systems. Reporting systems allow individuals to report errors, share information, and provide feedback on safety performance to identify trends, analyze causes, and implement corrective actions to prevent similar incidents in the future. Encouraging a culture of reporting, transparency, and accountability is essential for promoting error management, improving safety practices, and enhancing the reliability of safety critical systems in high-risk environments.

- **Safety Critical Communication**: Safety critical communication refers to the exchange of information, instructions, feedback, and reports that are essential for ensuring the safety and reliability of critical systems. Communication involves verbal, written, electronic, and visual interactions between individuals, teams, departments, and stakeholders to convey safety critical messages, coordinate activities, respond to emergencies, and prevent errors in high-risk environments. Effective communication strategies, tools, and protocols are essential for promoting a culture of safety, enhancing situational awareness, and ensuring error-free operations in safety critical settings.

- **Safety Critical Decision Making**: Safety critical decision making involves selecting courses of action, evaluating risks, and making choices that have a direct impact on the safety and reliability of critical systems. Decision making requires individuals to consider multiple factors, uncertainties, consequences, and alternatives to avoid errors, prevent accidents, and ensure safe outcomes in high-risk environments. Analytical thinking, problem-solving skills, critical reasoning, and situational awareness are essential for effective decision making in safety critical situations.

- **Safety Critical Leadership**: Safety critical leadership involves guiding, motivating, and supporting individuals, teams, and organizations to achieve safety goals, promote error management, and maintain the reliability of critical systems. Leadership includes setting safety priorities, establishing clear expectations, fostering a culture of safety, and providing resources, training, and feedback to enhance safety performance and prevent errors in high-risk environments. Effective safety critical leadership requires communication skills, decision-making abilities, conflict resolution, and resilience to manage risks, promote safety, and ensure the success of safety critical operations in industrial settings.

- **Safety Critical Collaboration**: Safety critical collaboration involves working together with individuals, teams, departments, and stakeholders to achieve safety goals, prevent errors, and maintain the reliability of critical systems. Collaboration includes sharing information, coordinating activities, resolving conflicts, and

making decisions collectively to enhance safety performance and ensure error-free operations in high-risk environments. Effective collaboration requires trust, communication, teamwork, and leadership to promote a culture of safety, build resilience, and achieve safety critical objectives in industrial settings.

- **Safety Critical Monitoring**: Safety critical monitoring involves continuously observing, analyzing, and assessing the performance of critical systems, processes, and environments to detect errors, anomalies, or deviations that could compromise safety and reliability. Monitoring activities include real-time data analysis, performance evaluations, alarm management, and other measures to ensure the effectiveness of safety controls, prevent errors, and respond to emergencies promptly in high-risk environments. Effective monitoring strategies, tools, and protocols are essential for promoting error management, enhancing situational awareness, and maintaining the reliability of safety critical systems in industrial settings.

- **Safety Critical Evaluation**: Safety critical evaluation involves systematically assessing the performance of safety critical systems, processes, and practices to identify strengths, weaknesses, and areas for improvement. Evaluation includes reviewing data, conducting audits, analyzing incidents, and soliciting feedback from stakeholders to verify compliance with safety standards, prevent errors, and enhance safety performance in high-risk environments. Continuous evaluation and feedback mechanisms are essential for promoting a culture of safety, learning from errors, and achieving safety critical objectives in industrial settings.

- **Safety Critical Improvement**: Safety critical improvement involves implementing corrective actions, best practices, and lessons learned from incidents to enhance the safety and reliability of critical systems. Improvement initiatives include updating procedures, training programs, equipment, and controls to prevent errors, reduce risks, and promote a culture of safety in high-risk environments. Continuous improvement is essential for adapting to changing conditions, optimizing safety performance, and ensuring the success of safety critical operations in industrial settings.

Challenges in Human Error and Error Management:

- Complexity**: Managing human errors in complex systems can be challenging due to the interconnected nature of processes, tasks, and individuals. Identifying, analyzing, and mitigating errors in complex environments requires a comprehensive understanding of human factors, system interactions, and organizational dynamics to prevent accidents and incidents effectively.
- Complacency**: Over time, individuals may become complacent or tolerant of errors, deviations, or unsafe practices, leading to a normalization of deviance. Addressing complacency requires promoting a culture of safety, accountability, and continuous improvement to prevent errors, maintain vigilance, and ensure the reliability of safety critical systems in high-risk environments.
- Uncertainty**: Dealing with uncertainties, ambiguities, and unforeseen events can challenge error management efforts in safety critical environments. Developing resilience, flexibility, and adaptive capabilities are essential for responding to unexpected errors, disruptions, or emergencies to maintain safety and reliability in dynamic and unpredictable situations.
- Communication**: Inadequate or ineffective communication can hinder error management by impeding

the exchange of critical information, instructions, or feedback necessary for preventing errors and promoting safety. Improving communication strategies, tools, and protocols is essential for enhancing situational awareness, teamwork, and decision-making in safety critical environments.

5. **Training and Competence**: Ensuring that individuals have the necessary knowledge, skills, and abilities to perform safety critical tasks can be a challenge. Developing comprehensive training programs, competency assessments, and performance evaluations are essential for preparing workers to manage risks, prevent errors, and maintain the reliability of safety critical systems in high-risk environments.

6. **Decision Making**: Making critical decisions under pressure, uncertainty, or time constraints can increase the risk of errors and compromise safety critical operations. Enhancing decision-making skills, problem-solving abilities, and risk assessments are essential for promoting error-free performance, preventing accidents, and ensuring safe outcomes in high-risk environments.

7. **Organizational Culture**: A culture that tolerates errors, blames individuals, or discourages reporting can undermine error management efforts and compromise safety performance. Fostering a culture of safety, open communication, learning, and accountability is essential for promoting error prevention, resilience, and continuous improvement in safety critical environments.