

A **CPS** HANDBOOK

Human Factors Handbook for Process Plant Operations

Improving Process Safety
and System Performance

**HUMAN FACTORS HANDBOOK
FOR PROCESS PLANT OPERATIONS**

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*Improving Process Safety and
System Performance*

**CENTER FOR CHEMICAL PROCESS SAFETY
AMERICAN INSTITUTE OF CHEMICAL ENGINEERS**
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Human Factors Handbook for Process Plant Operations
is dedicated to
Jack L. McCavit



Jack is passionate about process safety, especially in the areas of culture and human factors. His work, both in his career at Celanese, and after his retirement, has concentrated on educating workers and industry leaders on the importance of process safety, the payback of sustaining a great program, and most importantly, the impact of not making process safety a top priority. Jack had first-hand experience with the latter when he witnessed a butane vapor cloud explosion at the Celanese site in Pampa, Texas, in 1987, resulting in three fatalities and dozens of injuries. Based on his significant and relevant expertise, Jack was selected as the technical manager for the prominent Baker Panel investigation of the BP Texas City Explosion in 2005.

Jack is a CCPS Fellow, an AIChE Fellow, and is rumored to be the fifth most famous Texan in history. He was the committee chair for the CCPS flagship book, *Guidelines for Risk Based Process Safety*, and a driving force behind CCPS's Vision 20/20.

It is both an honor and a privilege to see Jack in action!

Louisa A. Nara, CCPSC
CCPS Global Technical Director

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Glossary

Accident: An event that can cause (or has caused) significant harm to workers, the environment, property, and the surrounding community.

Anthropometrics: The science of measuring the size and proportions of the human body (called anthropometry), especially as applied to the design of furniture and machines.

Behavioral marker: Non-technical behaviors that can be observed and described. They refer to a prescribed set of behaviors and are indicative of specific types of non-technical skills performance (e.g., effective decision-making in emergencies) within a work environment.

Cognitive overload: A mental state where an individual is unable to process all the information provided by the system.

Cognitive underload: A mental state when an individual is under-stimulated due to insufficient workload. This mental state leads to lack of attention.

Competency Assessment: System which allows measuring and documenting personnel competency. The goal of competency assessment is to identify problems with employee performance, and to correct these issues before they affect performance.

Competency: Set of skills and knowledge which enables a person to perform tasks efficiently, reliably and safely to a defined standard.

Competency Gap: Difference between the current competency level and the required competency level of an employee.

Competency Management: Method of categorizing and tracking the development of individual employee competency, allowing an organization to track progress, and identify future training needs.

Fatigue: Fatigue is a decline in physical and/or mental performance.

Hold Points: Point where change cannot happen until there has been verification that the prerequisites have been achieved.

Human Error: Intended or unintended human action or inaction that produces an unintended result. This includes, but is not limited to, actions by designers, operators, planners/schedulers, maintainers, engineers or managers that may contribute to or result in accidents [1].

Human Factors: Discipline concerned with designing machines, operations, and work environments so they match human capabilities, limitations, and needs. This includes any technical work (engineering, procedure writing, worker training, worker selection, operations, maintenance, etc.) related to the human interface in human-machine systems [1].

Human Performance: Measure of an individual's ability to execute a task effectively.

Incident: Event, or series of events, resulting in one or more undesirable consequences, such as harm to people, damage to the environment, or asset/business losses.

Job aid: Specific information or material intended to help workers execute a task more effectively.

Learning: Acquisition of knowledge or skills through study, experience, or being taught.

Major accident: Major accident means an occurrence such as a major emission, fire, or explosion resulting from uncontrolled developments in the course of the operation of any establishment, and leading to serious danger to human health or the environment (whether immediate or delayed) inside or outside the establishment, and involving one or more dangerous substances [2].

Mistake: A decision or judgement that is misguided.

Non-technical skills: The cognitive, social, and personal resource skills that complement technical skills and contribute to safe and efficient task execution [3].

Performance Influencing Factors (PIFs): Characteristics of the job, the individual and the organization that influence human performance [4].

Performance standards: Description of how the job is a description of what (actions/tasks) needs to be taken/executed, how the job must be done (behaviors/methods) and outcomes/results that will define satisfactory or acceptable performance.

Psychological safety: The outcome of an open workplace culture where people are willing to express an opinion, or admit mistakes or unsafe behaviors, without fear of being embarrassed, rejected, or punished.

Root cause: Fundamental, underlying, system-related reason why an incident occurred that identifies a correctable failure(s) in management systems. There is typically more than one root cause for every process safety incident.

Rota: A period of work taken in rotation with other workers (an abbreviation of rotation).

Rotation: A period of work taken in rotation with other workers.

Shift working (shifts): Work which takes place on a schedule outside traditional day work hours. It can involve evening or night shifts, early morning shifts, and rotating shifts.

Training: "Practical instruction in job and task requirements and methods. Training may be provided in a classroom or at the workplace, and its objectives are to enable workers to meet some minimum initial performance standards (minimum required competency level), maintain their proficiency, or to qualify them for promotion to a more demanding position" [5].

Vigilance decrement: Decline in "the ability to sustain attention and remain alert to a particular stimulus over a prolonged period of time" [6].

Table G-1 continued

Type of change	Potential impacts	Typical Human Factors actions
Staffing arrangements		
Reduction in number of supervisors or team leaders.	Ratio of staff to supervisors reduces capacity to support staff. Excessive supervisory workload, stress, and fatigue. Reduction in time for improvement activities.	Verify the “span of control” in respect of workload, level of supervision etc. Monitor workload and capacity for tasks such as improvement projects. Increase supervisory non-technical skills, such as leadership and delegation. Increase self-management competence of team members.
Outsourcing.	Creation of new communication and contact interfaces. Loss of in-house expertise. Reliance on continuity of service. Contractor does not adopt company safety values. Contractor lacks competence in site management procedures.	Formalize communications. Provide team bonding exercises. Determine the minimum level of in-house expertise to be retained. Offer a cultural induction. Provide contractor training and certification.

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