

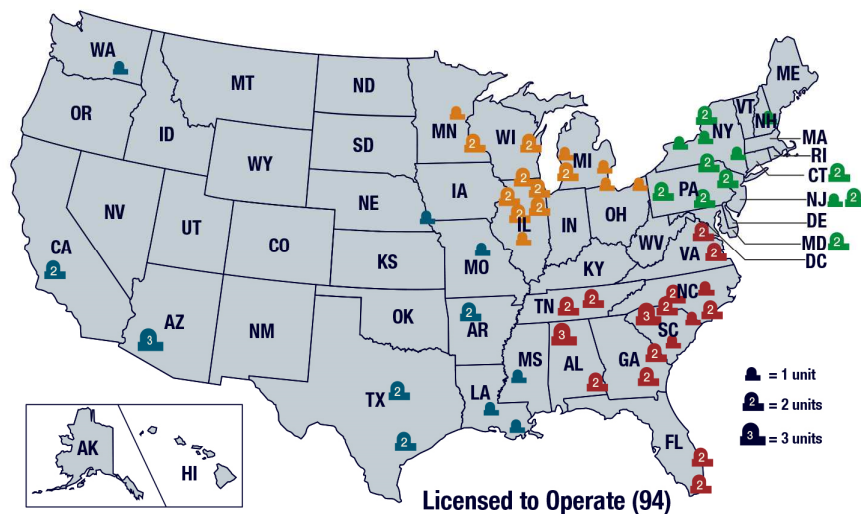
SPE Webinar: Origins of H&OP in the Commercial Nuclear Power Industry



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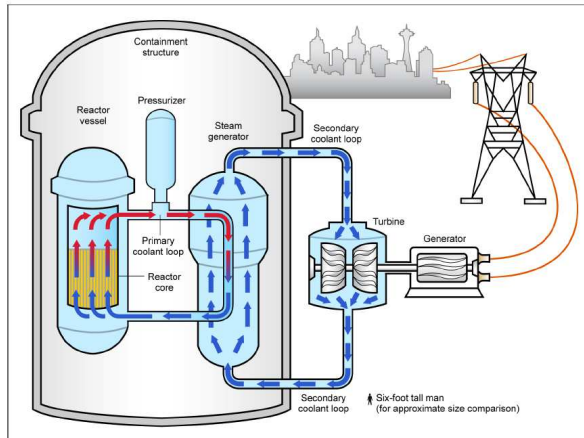
U.S. Operating Commercial Nuclear Power Reactors



Reactor Types in the U.S.



Pressurized Water Reactor (PWR)

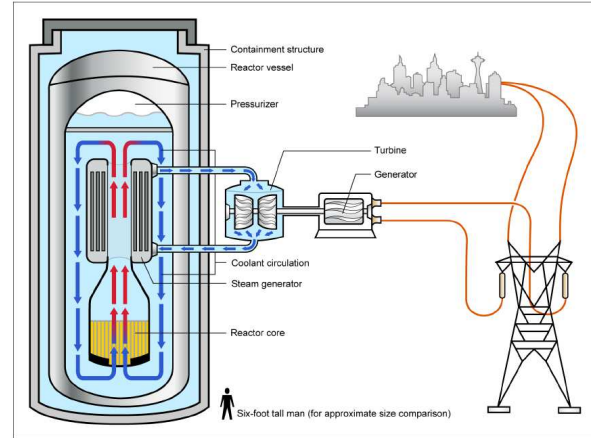


Source: GAO, based on Nuclear Regulatory Commission documentation | GAO-15-652



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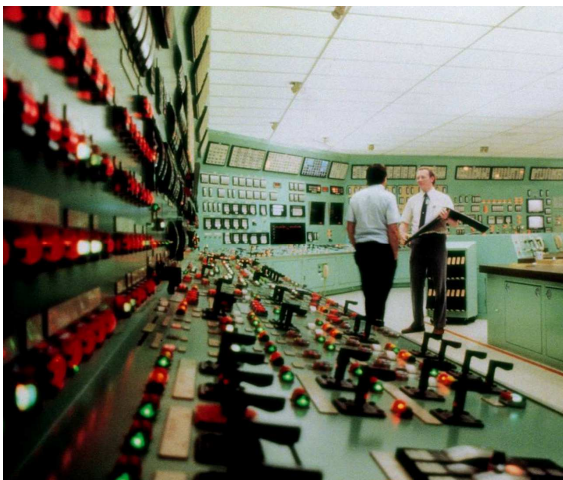
Boiling Water Reactor (BWR)



Source: GAO, based on Department of Energy documentation | GAO-15-652

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Three Mile Island (28 March 1979)



- **Regulator Response** (government):
 - Control room redesign (human factors)
 - Human Reliability Analysis
 - Procedures (symptom-based vs. event-based)
 - Management of accident response
- **Utility Response** (private)
 - INPO and plant evaluations (U.S. Navy ORSE)
 - Training & qualification of nuclear personnel
 - Human Performance Enhancement System (HPES)



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Hu and H&OP



Human Performance (Hu)

- To perform – to act in a way that accomplishes a desired outcome
- The behavior (B) and result (R) of individual effort in the workplace
- Behavior – what people think, say, or do; actions within local context
- Results – outcomes, good/bad
- **Hu = B + R (Individual)**



Human and Organizational Performance (H&OP)

- Focused on success and preserving the integrity of assets (managing risk)
- The collective performance of an organizational unit involving the work outputs of the unit's workers
- Performance within the systemic context of the organization's management processes, and technical and social environments
- **H&OP = Hu + System (Organization)**

Notable Events



- **Three Mile Island** (nuclear plant) (1979)
- Bhopal, India, (chemical plant) (1984)
- **Chernobyl** (nuclear plant) (1986)
- Challenger (space shuttle) (1986)
- Herald of Free Enterprise (ferry) (1987)
- Piper Alpha (oil rig) (1988)
- Exxon Valdez (oil tanker) (1989)
- **Davis-Besse** (nuclear plant) (2002)
- **Fukushima** (nuclear plant) (2011)
- Boeing 737 Max (airlines) (2019)

Major accidents that strongly influenced the nuclear industry's thinking and approach to human performance



Rare Photo of Nuclear Submarine Operations



U.S. Navy's Nuclear Program



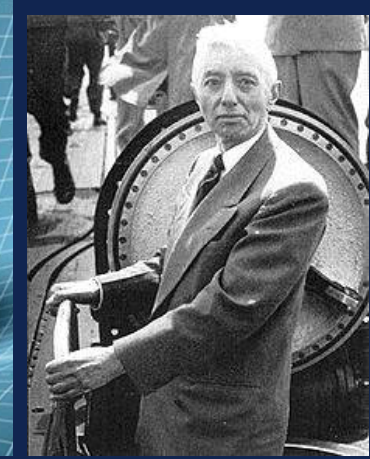
- No nuclear accidents:
- Effective Learning Organizations:
 - Recognized **High Reliability Organization (HRO)**
 - Benchmarked by NASA among others
- Foundation for operation of commercial nuclear utilities



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Rickover Industrial Principles (1983)*

1. Respect the technology.
2. Develop expertise.
3. Be conservative.
4. Know what is going on.
5. Get into the details.
6. Face the facts.
7. Accept responsibility.



Adm. Hyman G. Rickover



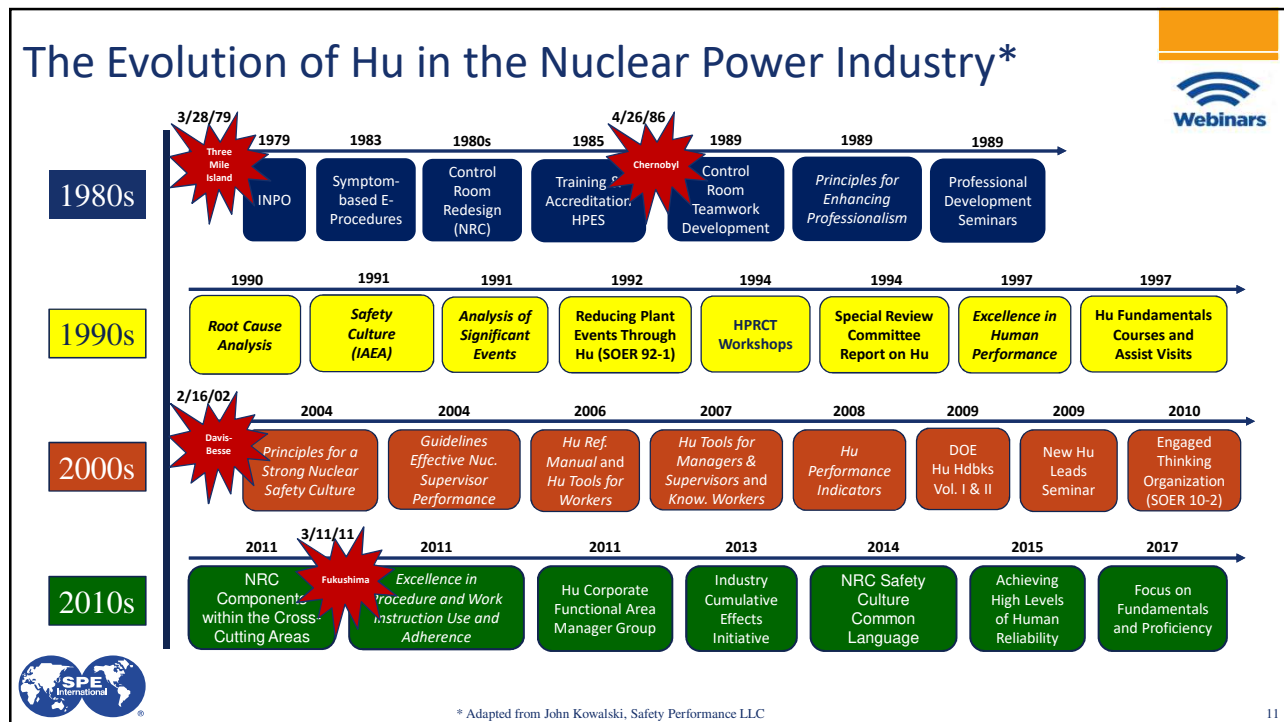
*Rickover, H. (19 November 1983). An Assessment of the GPU Nuclear Corporation and Senior Management and its Competence to Operate TMI-1. Retrieved from <http://archives.dickinson.edu/document-descriptions/admiral-hyman-george-rickovers-assessment-three-mile-island>.

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Primary Influencers on Industry Hu

• H.G. Rickover	U.S. Navy Nuclear Power Program	1950's-1990's
• Kemeny Commission	Report on the Accident at Three Mile Island	1979
• Swain & Guttman	Handbook of HRA with Emphasis on NPP Applications	1983
• Jens Rasmussen	Skill-Rule-Knowledge-based Human Performance	1983
• United Airlines	Crew Resource Management	1981
• Edgar Schein	<i>Organizational Culture & Leadership</i>	1985
• IAEA	Safety Culture (No. 75-INSAG-4) (Chernobyl)	1991
• INPO	In-reactor Fuel-damaging Events: A Chronology 1945-1990	1991
• James Reason	<i>Human Error Managing the Risks of Organizational Accidents</i>	1990/1998
• David Embrey	<i>Guidelines for Preventing Human Error in Process Safety</i>	1994
• Aubrey Daniels	<i>Bringing Out the Best in People Performance Management</i>	1994
• Tom Gilbert	Human Competence: Engineering Worthy Performance	1996
• INPO	Excellence in Human Performance Training Good Practices	1997-2007
• NRC	Hu Cross-cutting Issues (Reactor Oversight Process)	2000
• INPO	Principles of Nuclear Safety Culture (Davis-Besse)	2004
• INPO	Industry Cumulative Effects Initiative	2013





Shift in Focus (1991)

“The risk is in people.”

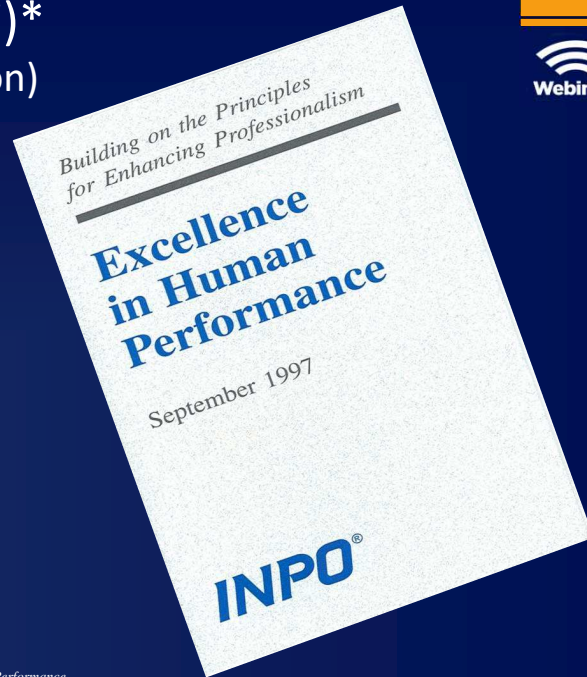
-Dr. Zack Pate
July 1991
President and CEO
INPO®

Another Shift in Focus (1997)* (collaboration with Dr. James Reason)

Behaviors for:

- Individuals
- Leaders
- Organizations

First INPO document alluding to the organization's influence on human performance



* INPO (Sep 1997). *Excellence in Human Performance*.

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INPO Hu Principles (1997)*

1. People are fallible, and even the best make mistakes.
2. Error-likely situations are predictable, manageable, and preventable.
3. Individual behavior is influenced by organizational processes and values.
4. People achieve high levels of performance based largely on the encouragement and reinforcement received from leaders, peers, and subordinates.
5. Events can be avoided by understanding the reasons mistakes occur and applying the lessons learned from past events.



* Source: INPO (Sep 1997). *Excellence in Human Performance*.

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Muschara H&OP Principles (2021)*



1. People have dignity and inherent value as human beings.
2. People are fallible.
3. People do not purposefully come to work to fail.
4. Behavior choices are predictable and manageable.
5. Risk is an inherent, dynamic property of the way an organization operates.
6. Organizations are perfectly tuned to get the results they are getting.
7. Conditions that spawn tomorrow's events exist today.



* Muschara, T. (2018). *Risk-Based Thinking*. Routledge (pp.5-8).

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Human Performance Reference Manual (2006)*



This manual assists managers, support staff, supervisors, human performance professionals, and workers to:

1. Develop a coherent strategic approach to minimizing the frequency and severity of events triggered by human error.
2. Understand the factors that cause and prevent human error.
3. Stimulate organizational *improvement* by finding and eliminating conditions that either provoke human error or inhibit the effectiveness of defenses against human error.
4. Adopt leader practices that align the organization and its culture to more reliably support *excellent* human performance.
5. Promote a common language and understanding of human performance concepts and terms.

$$R_e + M_d \rightarrow \emptyset E$$



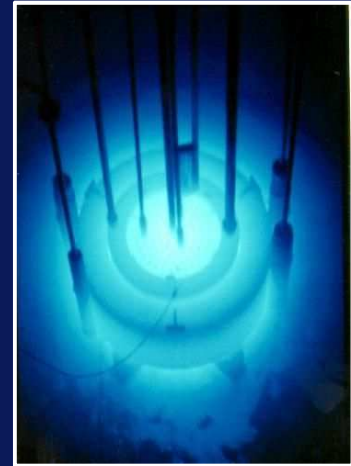
* INPO (October 2006). *Human Performance Reference Manual* (INPO 06-003).

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Safety Culture Principles (2004)*



1. Everyone is personally responsible for nuclear safety.
2. Leaders demonstrate commitment to safety.
3. Trust permeates the organization.
4. Decision-making reflects safety first.
5. Nuclear technology is recognized as special and unique.
6. A questioning attitude is cultivated.
7. Organizational learning is embraced.
8. Nuclear safety undergoes constant examination.



*INPO, *Principles for a Strong Nuclear Safety Culture*, November 2004.

Safety Culture Traits (2012)*



- Personal Accountability
- Leadership's Safety Values and Actions
- Respectful Work Environment
- Decision-Making
- Questioning Attitude
- Environment for Raising Concerns
- Effective Safety Communications
- Problem Identification and Resolution
- Continuous Learning
- Work Processes

Nuclear Safety Culture

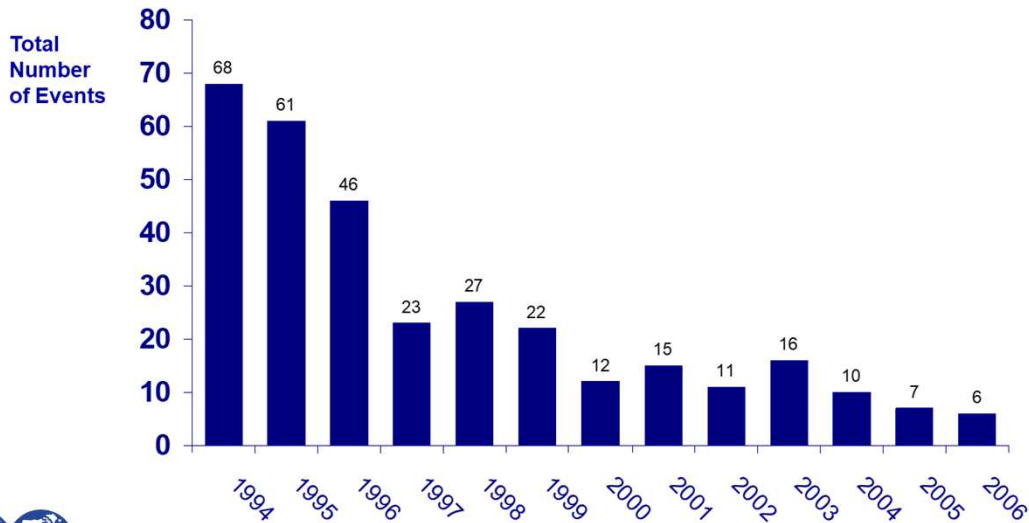
is defined as the core values and behaviors resulting from a collective commitment by leaders and individuals to emphasize safety over competing goals to ensure protection of people and the environment.

Manifested by patterns of thinking, feeling, and behaving that emphasize safety in goal conflict situations



*INPO, *Traits of a Healthy Nuclear Safety Culture*, April 2013.

Hu Impact on U.S. Nuclear Industry*



* Source: INPO Event Database, 2007.

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Potential Pitfalls (my opinion):



- Never fully matured to H&OP: lack of systems perspective
- Prevailing mindset on error-prevention (non-technical skills)
- Industry Cumulative Effects Initiative (2013)
- Cutting corners to “deliver the nuclear promise” (2017-2018)
- Mistakes perceived as weaknesses in one’s “professionalism” (i.e., nuclear professional)
- “Managing” nuclear safety culture (an emergent property)
- Uncertain of science bases undergirding current approaches?



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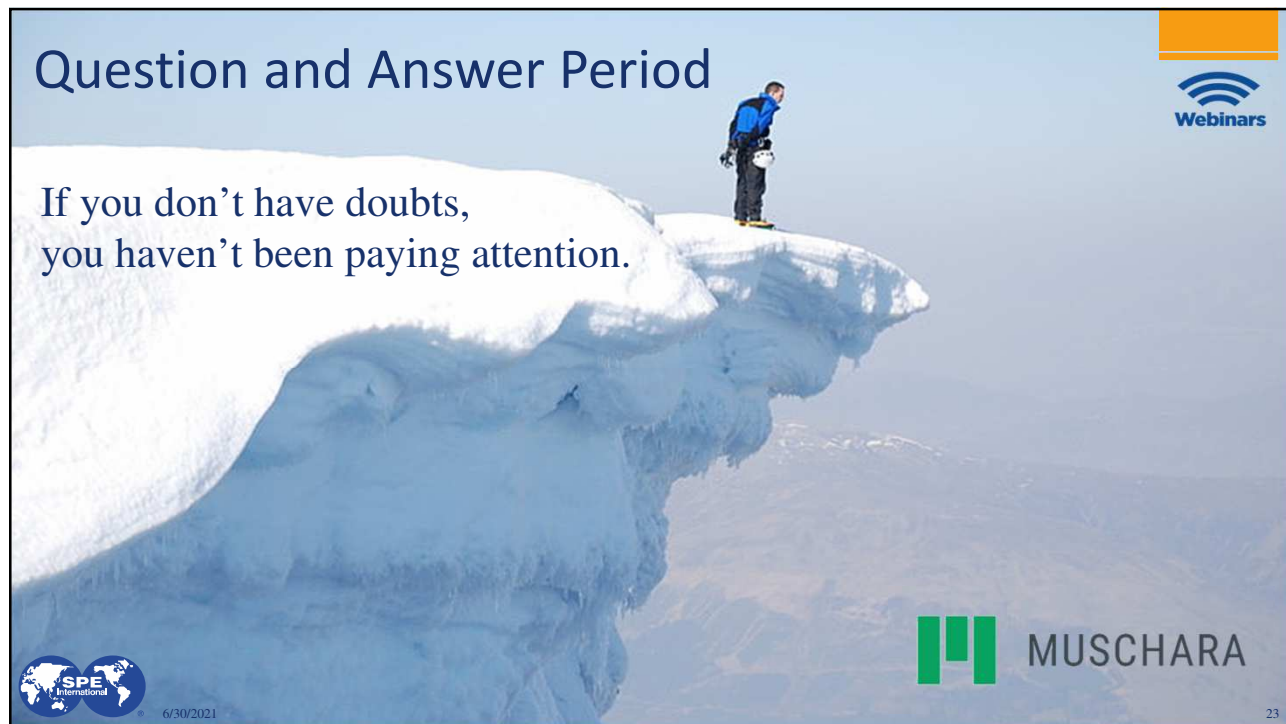
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Question and Answer Period

If you don't have doubts,
you haven't been paying attention.



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