INPO's Approach to Human Performance in the U.S. Commercial Nuclear Industry

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INPO's Mission

…to promote the highest levels of safety and reliability — to promote excellence — in the operation of nuclear electric generating plants.

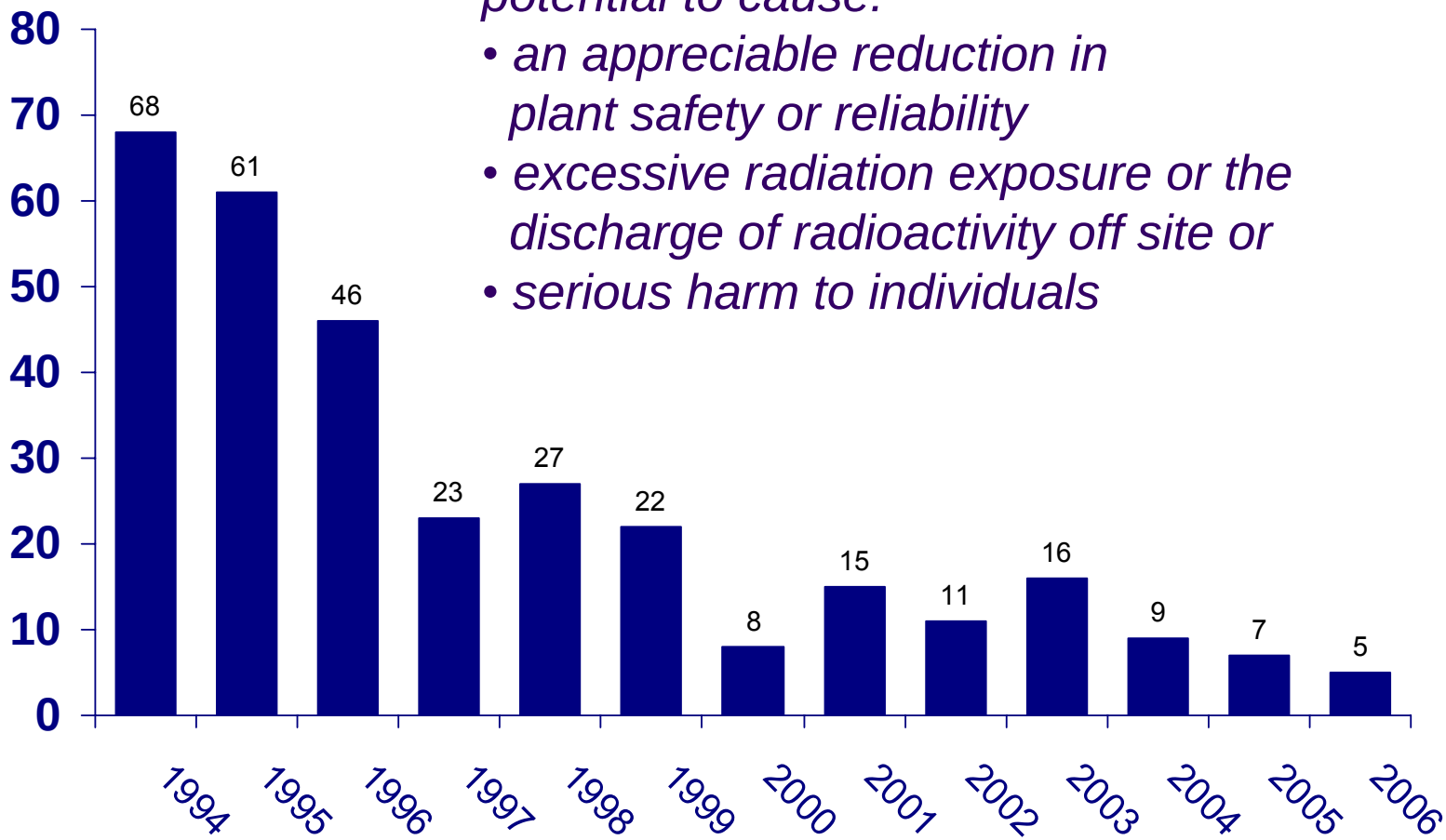
… Nuclear Safety…

1. **Concentrated Power** – reactivity management
   - λ Reactivity and power level controls
   - λ Rod control & drive reliability
   - λ Instrumentation reliability
2. **Decay Heat Load** – inventory and cooling
   - λ Reactor cavity and fuel pool
   - λ Secondary plant equipment reliability
   - λ Safety system reliability and controls
   - λ Plant materials integrity and design margins
3. **Radioactive Material** – barrier integrity
   - λ Containment integrity
   - λ Defect-free fuel
   - λ Primary systems integrity

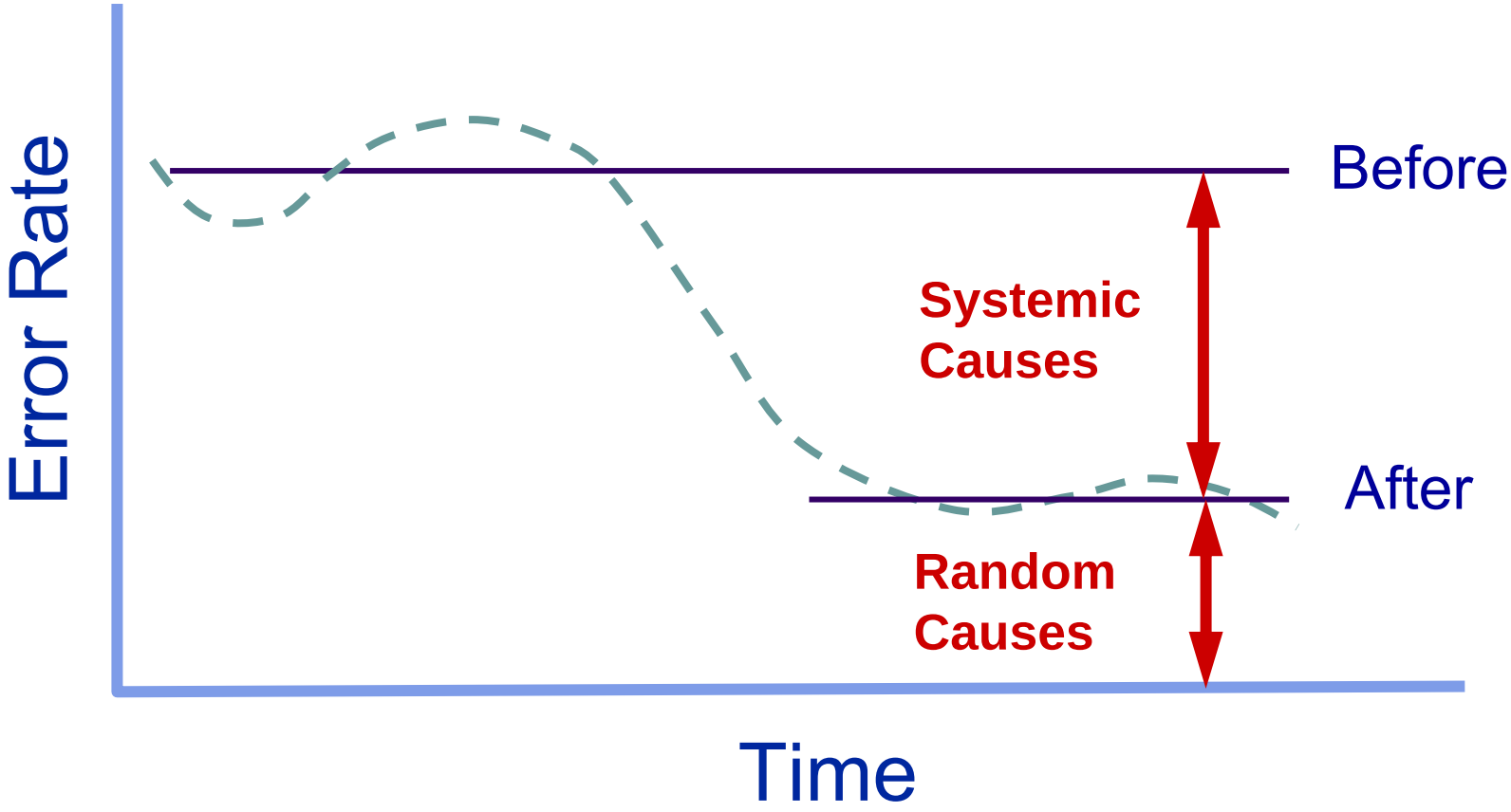
Significant Events – USA

An event that caused or had the potential to cause:

- *an appreciable reduction in plant safety or reliability*
- *excessive radiation exposure or the discharge of radioactivity off site or*
- *serious harm to individuals*



Error Rate Reduction

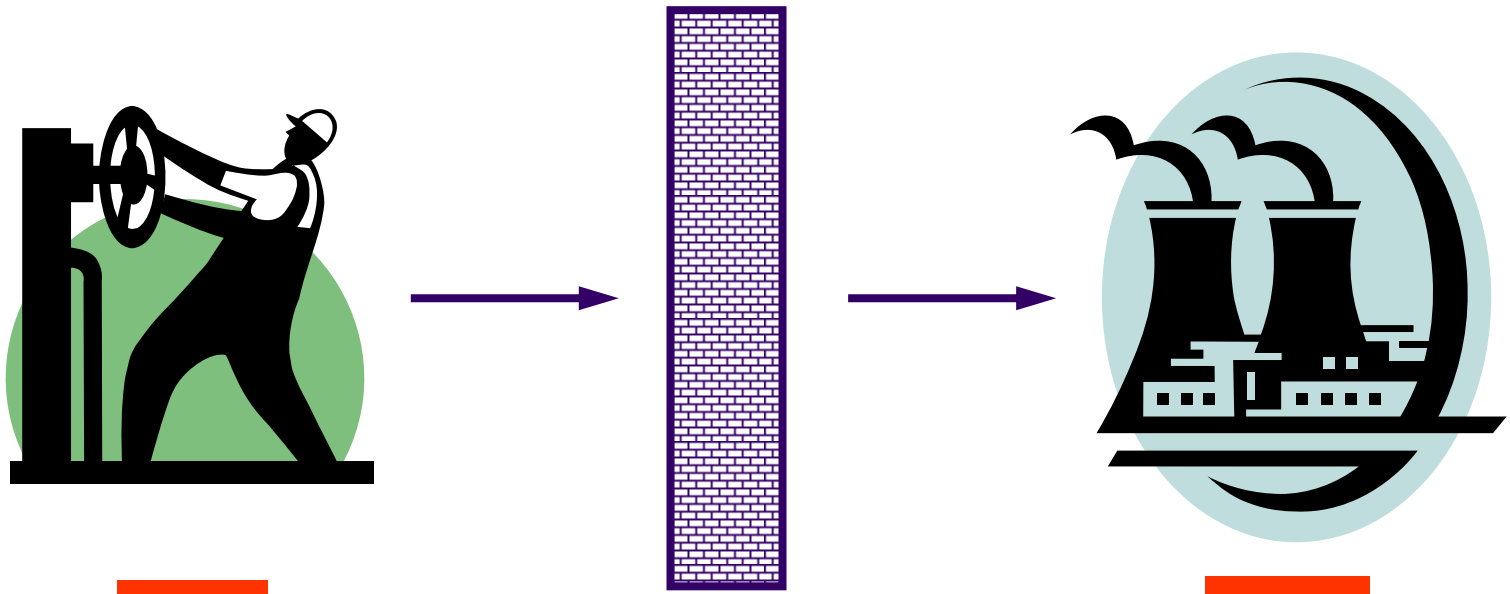


Hazard – Barrier – Asset

Hazard:
Human – “touching”

Barrier(s):
Less than Adequate or Missing

Asset:
Object to Protect



What is Managed?

- Assets: people, plant, and property
- Hazard: human error
- Exposure: "People *touching* equipment"
- Risk: probability and consequences
- Event: ▼ frequency and ▼ severity
- Controls:
  - **error rate** (frequency) → reduce active errors
  - **defense-in-depth** (severity) → reduce latent conditions

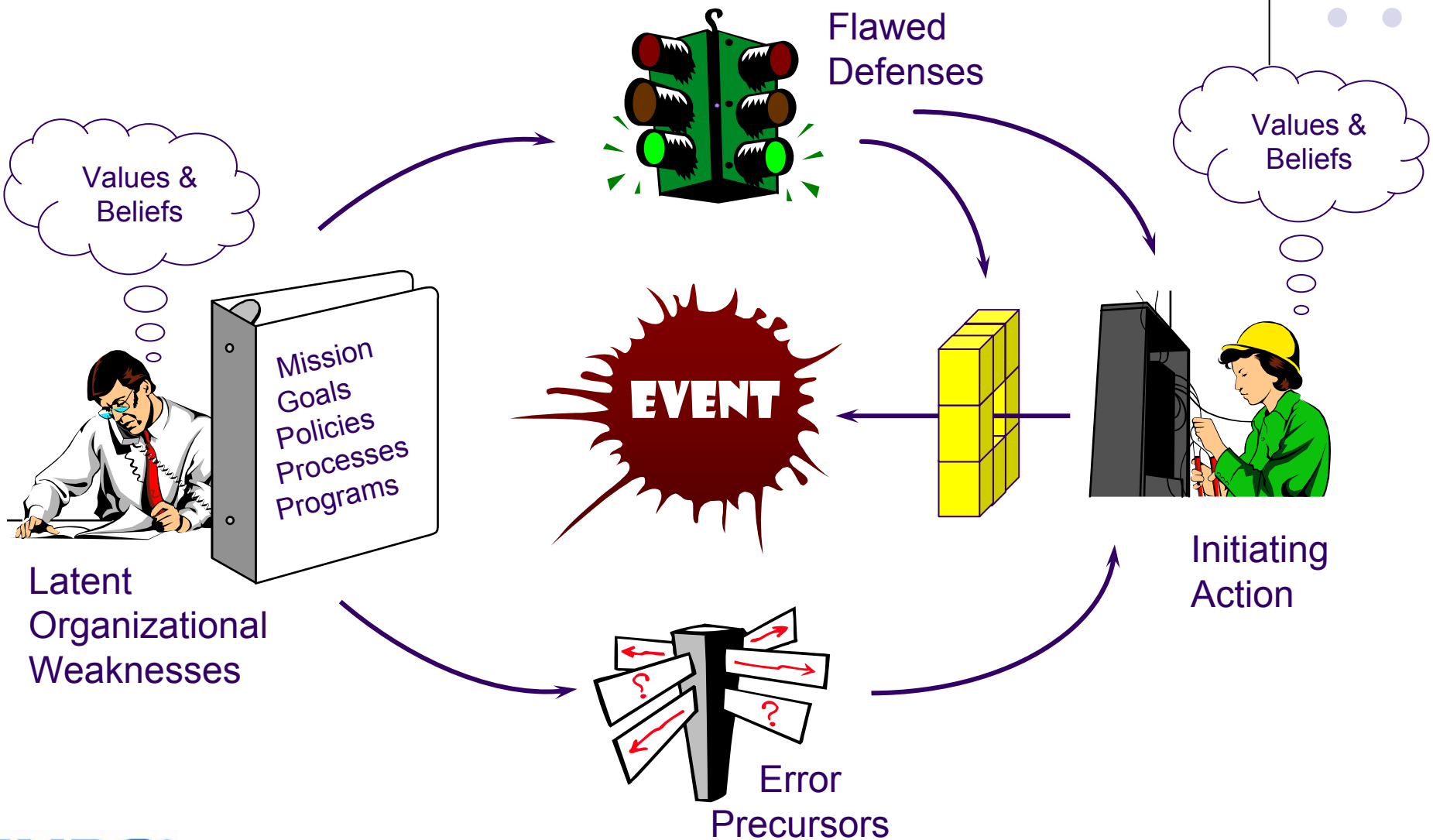
Strategic Approach to Hu

$$R_e + M_d \rightarrow ØE$$

Reducing error **and** Managing defenses *leads to* **ZERO** Events

Identify
Analyze
Correct

Anatomy of an Event



Performance Model

*Risk-based Approach**

- Human unreliability and equipment risk can not be managed the same.
- Process of assigning controls for human work activities uses a *graded approach*.
- Controls are *proportionate* to the risk or potential consequence.

* IAEA, *Management of Operational Safety in Nuclear Power Plants* – a report by the International Safety Advisory Group, final draft, 1999.

Work Execution

"touching" the plant

R_e

- **Work Preparation**
  - planning, walkdowns, task assignments and pre-job briefings
- **Work Performance**
  - uneasiness (wariness), situation awareness, Hu tools, teamwork and supervision
- **Work Feedback**
  - reporting and observations

Critical Step

Critical Step – a procedure step, series of steps, or action that if done improperly *will* cause (*immediate*) *irreversible harm* to equipment or people, or significantly impact plant operation

Defenses

- **Engineered Controls**
  - equipment reliability, software & hardware configuration, human-machine interface
- **Administrative Controls**
  - procedures, training, processes, policies, expectations and standards
- **Cultural Controls**
  - assumptions, values, beliefs, attitudes, work group norms, and leadership
- **Oversight Controls**
  - accountability, performance improvement

Managing Defenses

M_d

1. **Identify** unsafe condition(s)
2. **Analyze** its cause(s) and extent of condition
3. **Correct** the condition(s)

Organizational Factors

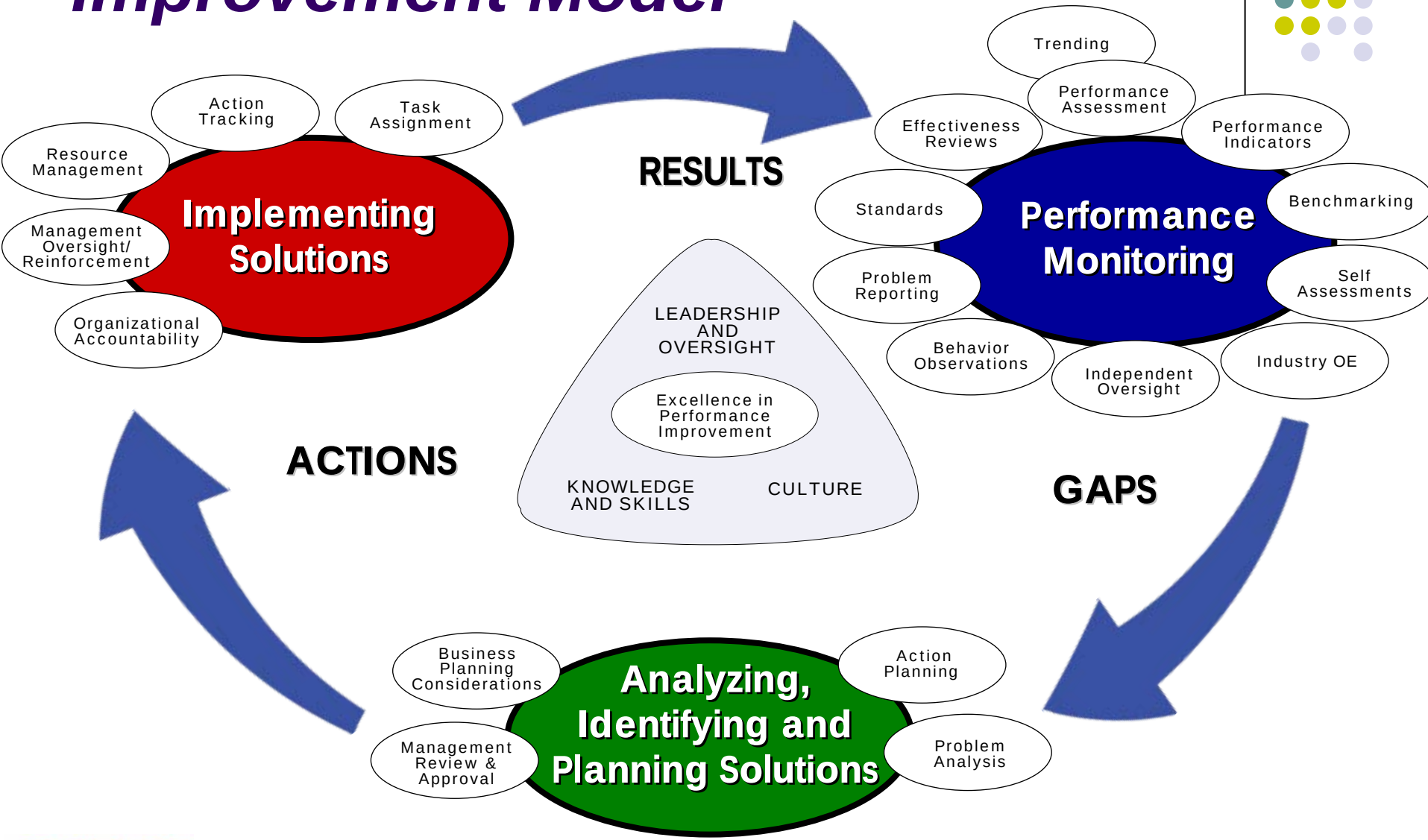
1. Mission
2. Organizational structure
3. Clear direction
4. Work management
5. Administrative controls
6. Hazard control processes
7. Training & qualification
8. Engineering processes
9. Performance improvement processes
10. Technology
11. Human resources
12. Conservative decision making
13. Communication
14. Managerial/supervisory practices

Safety Culture Principles*

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.

INPO Performance Improvement Model



OR.3 Human Performance

"Station personnel select and apply appropriate error prevention techniques commensurate with the importance of assigned tasks to minimize the frequency and consequences of events."

- Organizational Factors
- Job-Site Conditions
- Individual Behaviors

R_e

M_d

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