The Fukushima Daiichi Accident

A matter of unchallenged basic assumptions

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International Atomic Energy Agency

Objectives

- Provide a background on the report
- Explain how the work was approached
- Share the observations and lessons learned

The Fukushima Daiichi Accident

- One report by the IAEA Director General
- Five technical volumes
- The result of extensive international collaborative effort
- Five Working Groups
- 180 experts
- 42 Member States

> *“This report presents an assessment of the causes and consequences of the accident at the Fukushima Daiichi nuclear power plant in Japan, which began on 11 March 2011. Caused by a huge tsunami that followed a massive earthquake, it was the worst accident at a nuclear power plant since the Chernobyl disaster in 1986.”*
>
> Yukiya Amano, IAEA Director General
>
> www-pub.iaea.org/books/IAEABooks/10962/The-Fukushima-Daiichi-Accident

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Human and Organizational Factors and, Safety Culture Analysis

Objectives:

*As a part of the overall IAEA Fukushima Report, examine how human and organizational factors and safety culture contributed to the event in a comprehensive manner to address the "**whys**" of the event*

- Perform a **systemic analysis** of the accident capturing the relationship and synergies with those involved
- Provide an understanding so that the necessary **lessons learned** can be acted upon by governments, regulators and nuclear power plant operators throughout the world

Basis for a Sound Methodology

The human and organizational analysis was conducted in accordance with social and behavioral science procedures, which comprise of four important elements:

- Recognized methodology
- Qualitative data
- Scientifically-recognized theory
- Diversified competencies

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Human and Organizational Factors Team

- The HOF Team was part of Working Group 2 – 38 experts overall for the Safety Assessment Team

- The HOF Team - 11 experts:
  - Kathleen Heppell-Masys, Team Lead, CNSC
  - Monica Haage, Technical Lead, IAEA
  - Amanda Donges, INPO, U.S.
  - Hanna Kuivalainen, STUK, Finland
  - Sonja Haber, IAEA
  - Cornelia Ryser, ENSI, Switzerland
  - Birgitte Skarbø, IAEA
  - Per Chaikiat, SSM, Sweden
  - Luigi Macchi, Dedale, France /VTT, Finland
  - Kunito Susumu, TEPCO, Japan
  - Takafumi Ihara, TEPCO, Japan

Broad experience, vast knowledge and various competencies

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Systemic Analysis Data Collection

- Ten primary source reports selected for extracting facts
  - All facts were assigned to a category and one or more attributes
  - The HOF Team jointly developed a list of categories and attributes
  - Created a Database of facts assigned a category and attribute (s)

- Collecting factual information from various other sources:
  - Collaboration and regular exchange with all the other working groups
  - 30 additional relevant reports
  - Reports from IAEA Consultancy Meetings in Japan
  - Interview with Professor Hatamura, former Chairperson of Investigation Committee on the Accident at the Fukushima Nuclear Power Stations

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Example of Cumulative Database

Reading List	Fact Code	Fact	Category	Attribute/Qualifier	Description	Timeline (B,D,A)	Organization
6a	Icf21	To the question, “Don’t you think it was possible to propose the development of AM based on seismic PSA?” He (Kondo, chairman of the Special Committee on Safety Goals by NSC) answered, “We could have made such a decision. The question was when to make that decision. With regard to seismic PSA, we intended to start it on the occasion of the periodical safety review (PSR). Although the first-round PSR reviewed only internal event PSA, we had no choice about that, I intended to include external event PSA in the second-round PSR 10 years later. (p. 365)	Regulatory culture	Regulatory practice		B	NSC, Government
14	If4	“moreover, those additional protective measures were not reviewed and approved by the regulatory authority” (p. 13 and 45)	Regulatory Framework	Roles & Responsibilities		B	Regulator
4	T102	“The legally mandated METI order to continue seawater injection was issued at 10:30 on March 15. This information was shared via teleconferencing at 10:37. The document containing the METI order stated that “reactor injection is to be performed as early as possible, with D/W venting performed as needed.”” (p.219)	Roles & Responsibilities	Organizational Interfaces		D	IF, TEPCO, METI
4	T72	“The station and head office response HQs were notified that the TEPCO government attaché decision was “the Prime Minister has not approved seawater injection” at 19:25. After deliberation between the head office and station, it was decided that seawater injection would be halted.” (p. 183)	Roles & Responsibilities	Organizational Structure (Hierarchy)	[illegible]	[illegible]	[illegible]
4	T74	“However, due to the decision by the Site Superintendent that [illegible] injection was vital in preventing acciden[illegible] continued in actu[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
3	D5-91	[illegible] chamber and its [illegible] have been injecting seawater into the nuclear [illegible] full throttle and have begun to temporarily move our contractors and employees not directly involved in this operation to a safe location.” [140] As compared with the report made to the regulators, the press release was evidently delayed with severely constrained content. P.43	[illegible]	[illegible]	[illegible] to the public	[illegible]	TEPCO
3	D5-94	From their position as an operator under the regulation of the Kantei and other regulators, this action may make sense. But to give this position priority over transparency, while the safety of local residents was at risk, uncovered issues related to their corporate culture. p43 (see page 44 Excerpt from Statements material created by TEPCO)	Regulatory Culture	Adhered to Procedures or Requirements	Corporate Culture		TEPCO, other regulators and the Kantei

4,900 facts classified into 26 categories, 96 attributes

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Analysis: Mapping Exercises

- Identified and peer-reviewed facts from key sources
- Sorted facts by category or attribute for the team to review
- As a team, performed a two-fold mapping exercise identifying relationships, concepts and trends resulting in mini-themes and overarching themes
- Drafted the text on mini themes and overarching themes based on the mapping exercises

Keeping in Mind our Natural Tendencies

Learning opportunity

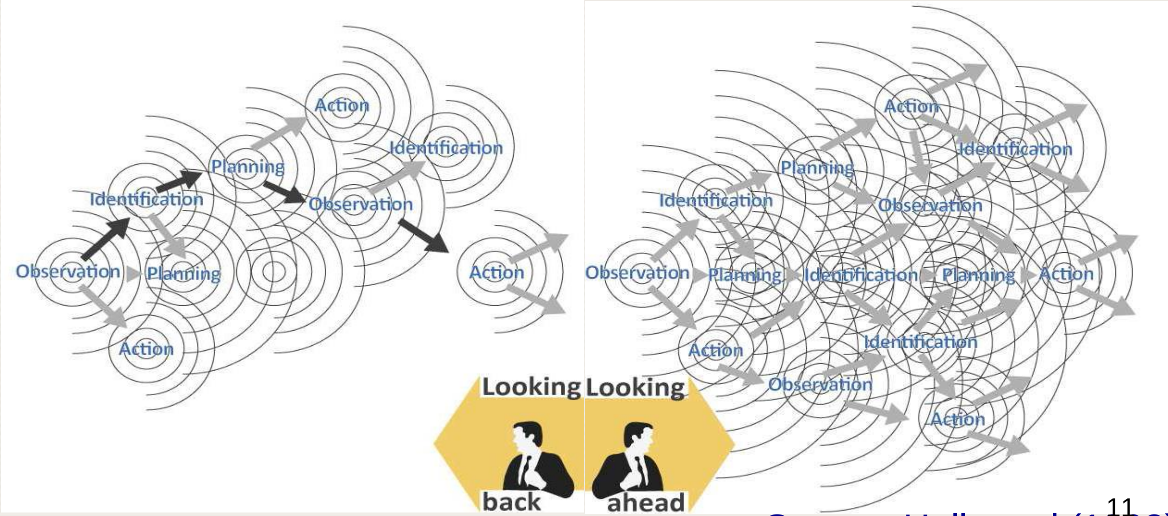
- Window for opportunity to learn opens up post-accident, some important lessons tends to be immediate
- Other Important lessons tend to emerge over time and need to be considered

Distancing through differencing

- Our learning after an accident is subject to barriers
- Mechanism called “distancing through differencing” - *“ this can’t happen here! ”*
  - Example: 1999 flooding event at the Le Blayais NPP in France.
- Oversimplification: Despite the efforts made to analyse the accident from many different perspectives, what happened is describe linearly

The hindsight bias

- It explains the pitfalls of understanding an event retrospectively
- The knowledge of the outcome thus deeply influences the understanding



Source: Hollnagel (1998)

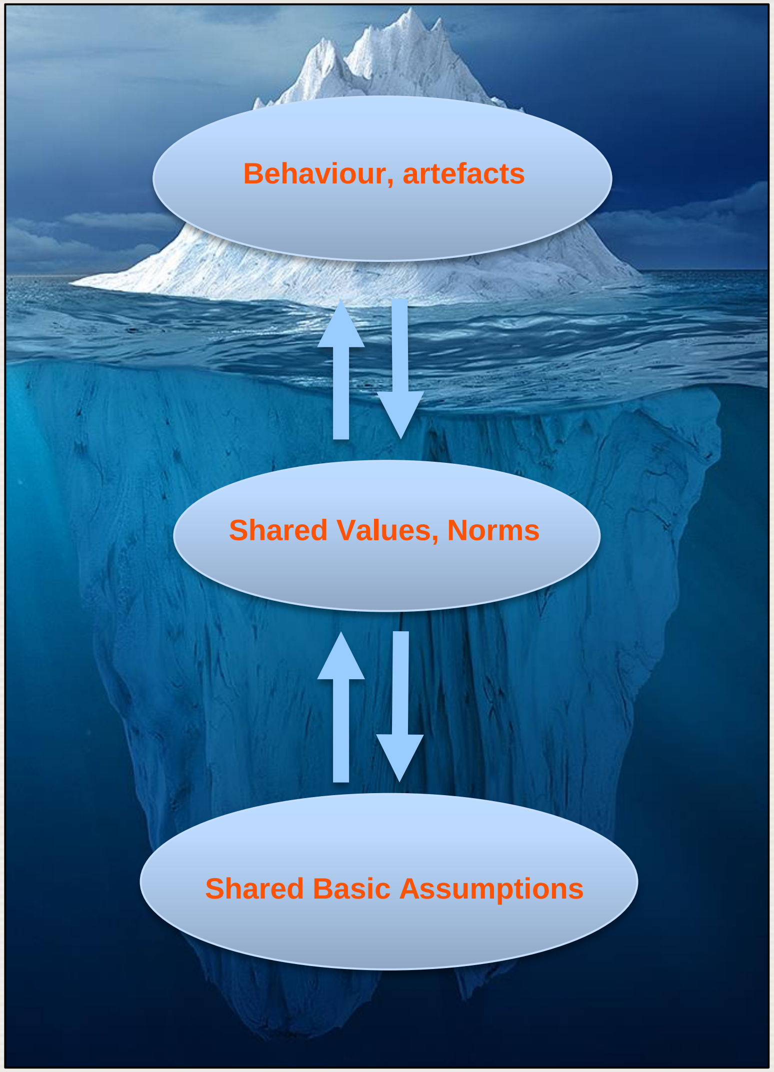
HUMAN AND ORGANIZATIONAL FACTORS

2 Observations and 7 Lessons Learned

First Observation – Shared Basic Assumptions

Over time, the stakeholders of the Japanese nuclear industry developed a shared basic assumption that plants were safe

- Led stakeholders to believe that a nuclear accident would not happen
- Constrained their ability to anticipate, prevent and mitigate the consequences of the earthquake triggering the Fukushima Daiichi accident



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Shared Basic Assumptions Across Stakeholders

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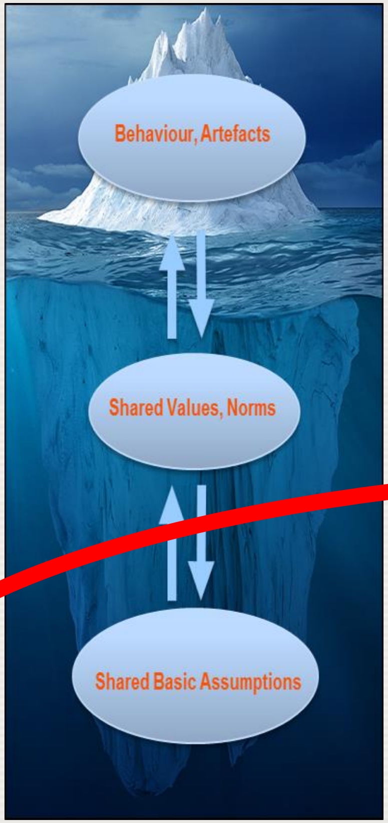
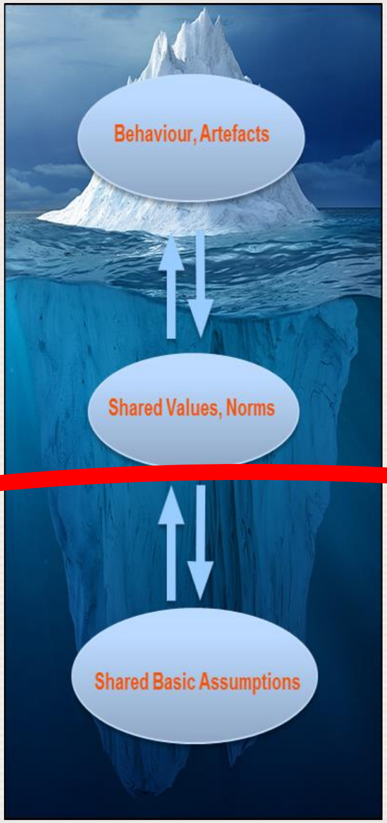
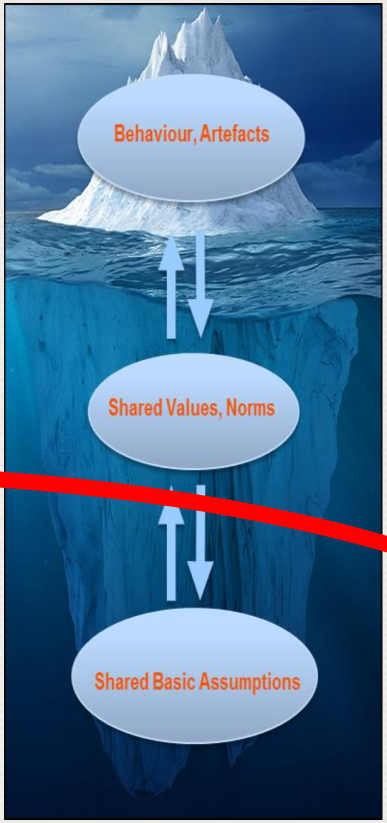


Public/government



Regulatory body



"We are safe"

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Lessons Learned 1

Lessons Learned:

1. Individuals and organizations need to consciously and continuously <u>question </u>their own basic assumptions and their implications on actions that impact nuclear safety.

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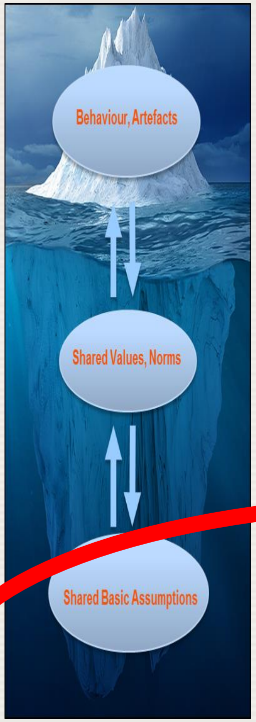

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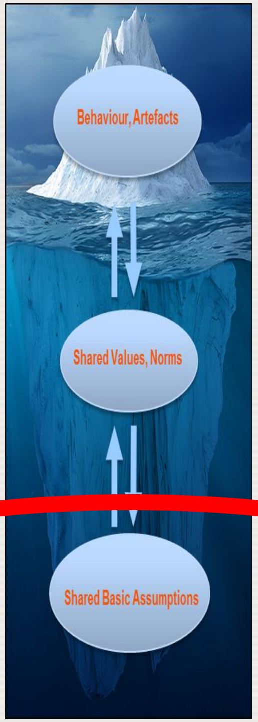
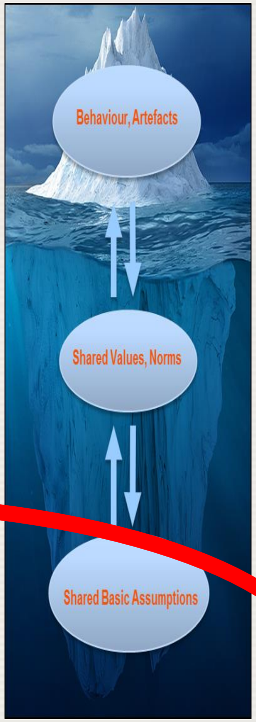


Regulatory body



"Are we safe?"

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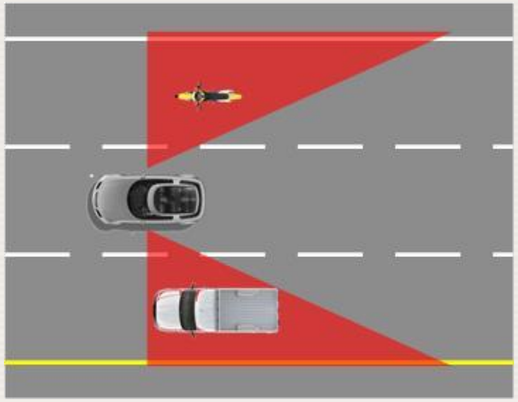
Reflecting on Basic Assumptions

- What mechanisms do you have in place to enable you to validate your shared assumptions?

- Do you know your blind spots?



- What do you take for granted in your area of expertise?

- What do you pay attention to? What do you not pay attention to?

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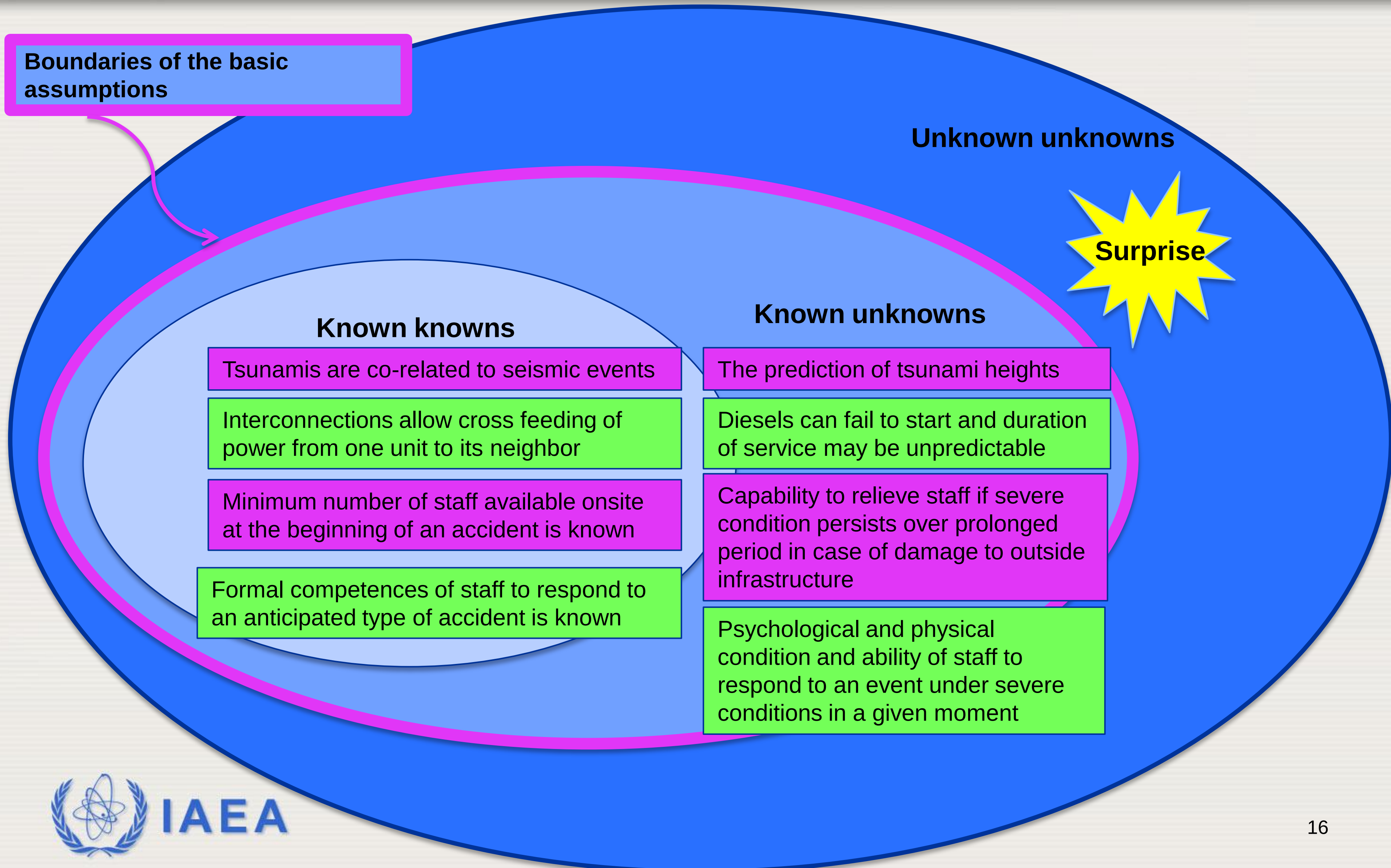
The Boundaries of our Basic Assumptions



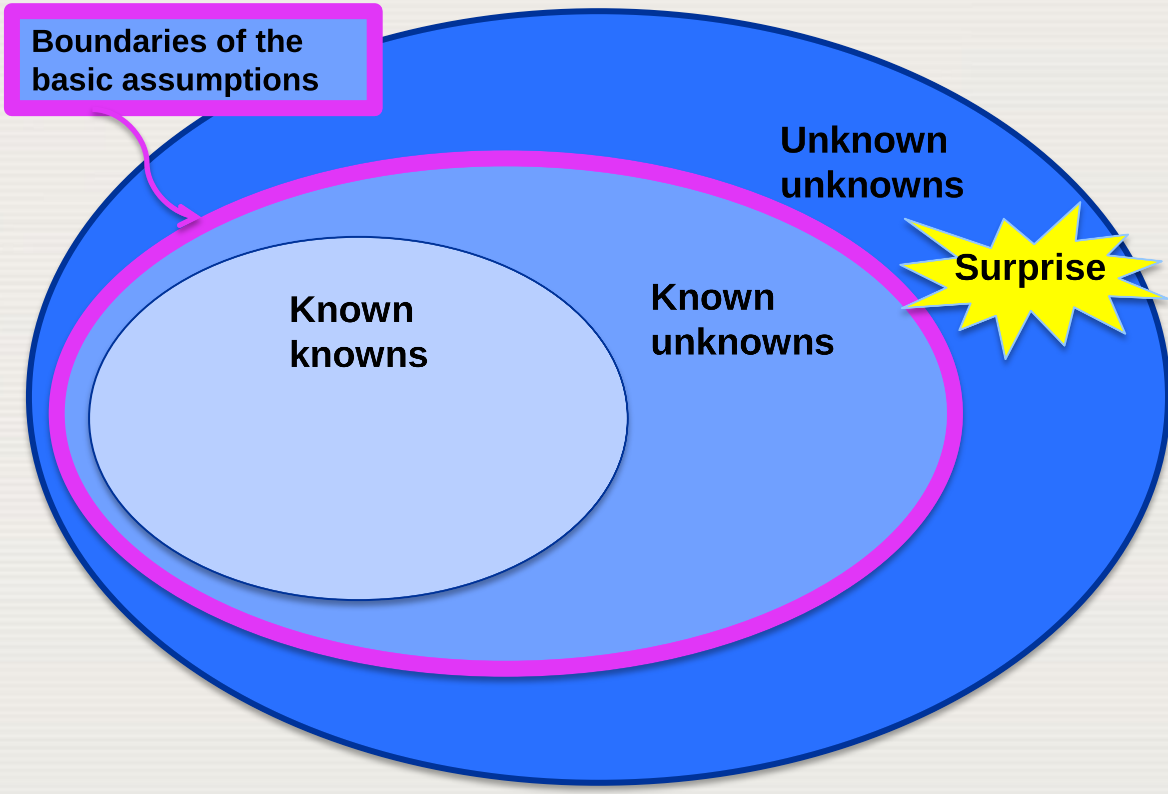
Lessons Learned 2 and 3

The accident was a surprise outside the boundaries of the basic assumption of the key stakeholders, meaning the stakeholders had not been able to imagine that such an accident could occur.

Lessons Learned 2 and 3 :

2. The possibility of the unexpected needs to be integrated into the existing worldwide approach to nuclear safety

3. Nuclear organizations need to critically review their approaches to emergency drills and exercises to ensure that they take due account of harsh complex conditions and unexpected situations.



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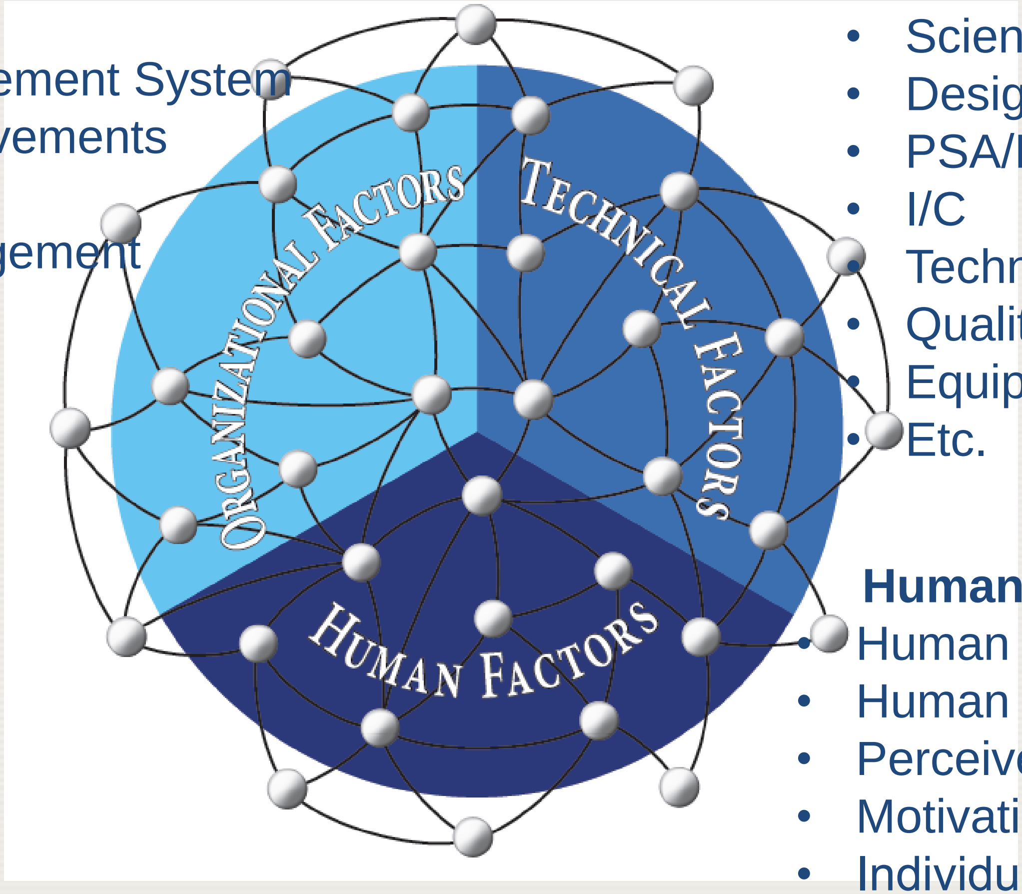
Second Observation

Observation:

While the stakeholders involved in the accident at the Fukushima Daiichi NPP were aware of the possibility of isolated issues related to the accident in advance, they were not able to anticipate, prevent or successfully mitigate the outcome of the complex and dynamic combination of these issues within the sociotechnical system.

Human, Organizational and Technical Factors within the Sociotechnical System

Organizational Factors
- Vision and objectives
- Strategies
- Integrated Management System
- Continuous improvements
- Priorities
- Knowledge management
- Communication
- Contracting
- Work environment
- Culture
- Etc.



Technical Factors
- Existing technology
- Sciences
- Design
- PSA/DSA
- I/C
- Technical Specifications
- Quality of material
- Equipment
- Etc.

Human Factors
- Human capabilities
- Human constraints
- Perceived work environm't
- Motivation
- Individuals' understanding
- Emotions
- Etc.

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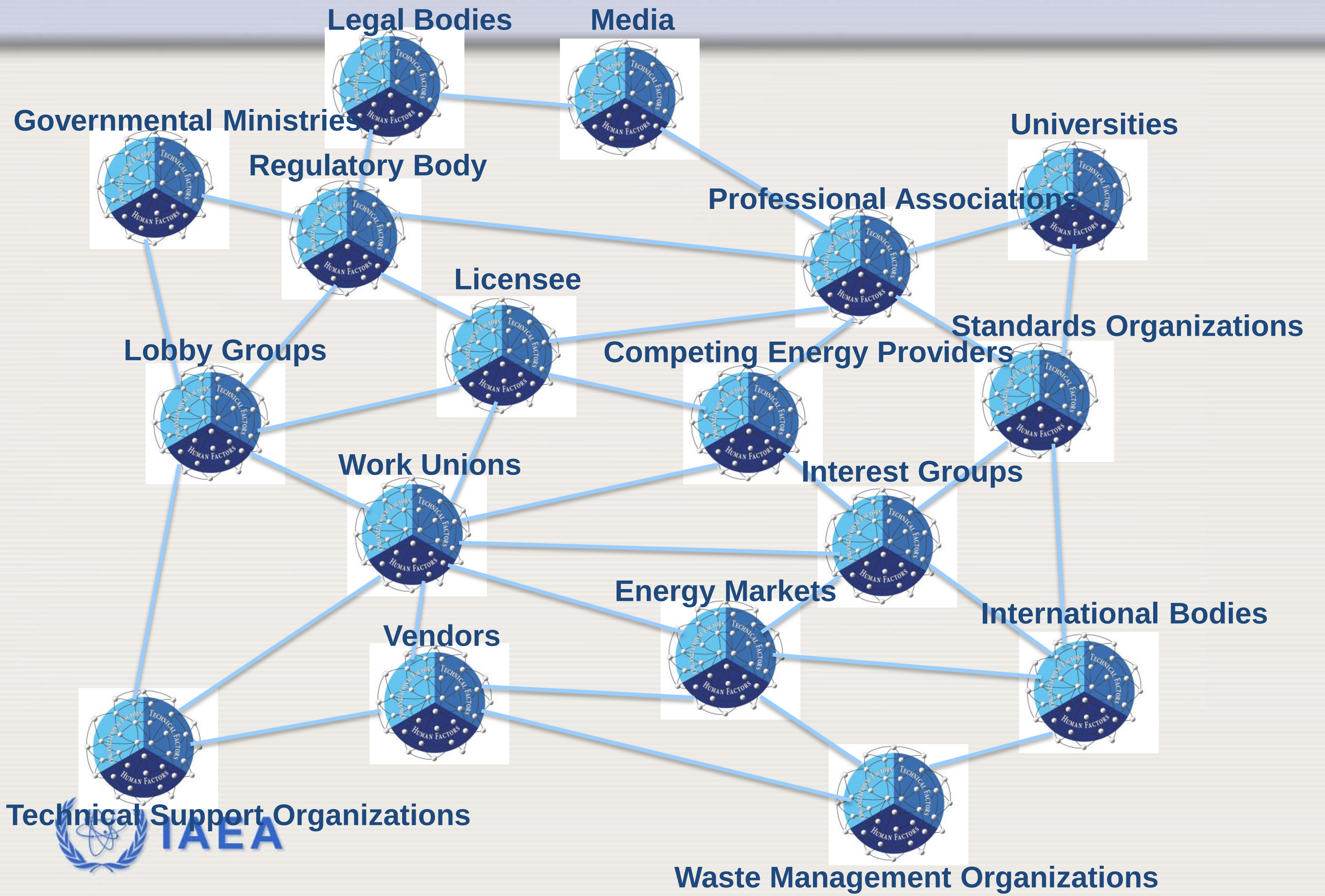
The Systemic Approach to Safety

- Works to comprehend the whole system of interplay between Humans, Technology and Organization (HTO)
- As the whole system is far too complex for one individual to comprehend, an integrated approach is needed, which invites different competencies and thinking
- Understanding the dynamics of the HTO interactions helps to evaluate the resilience abilities of the sociotechnical system
- Provides opportunity to take proactive actions to build human and organizational resilience capabilities that support safety outcomes more effectively
- A systemic approach to safety offers a complementary safety perspective to Defence in Depth

Systemic View of Interactions within the broader Sociotechnical System

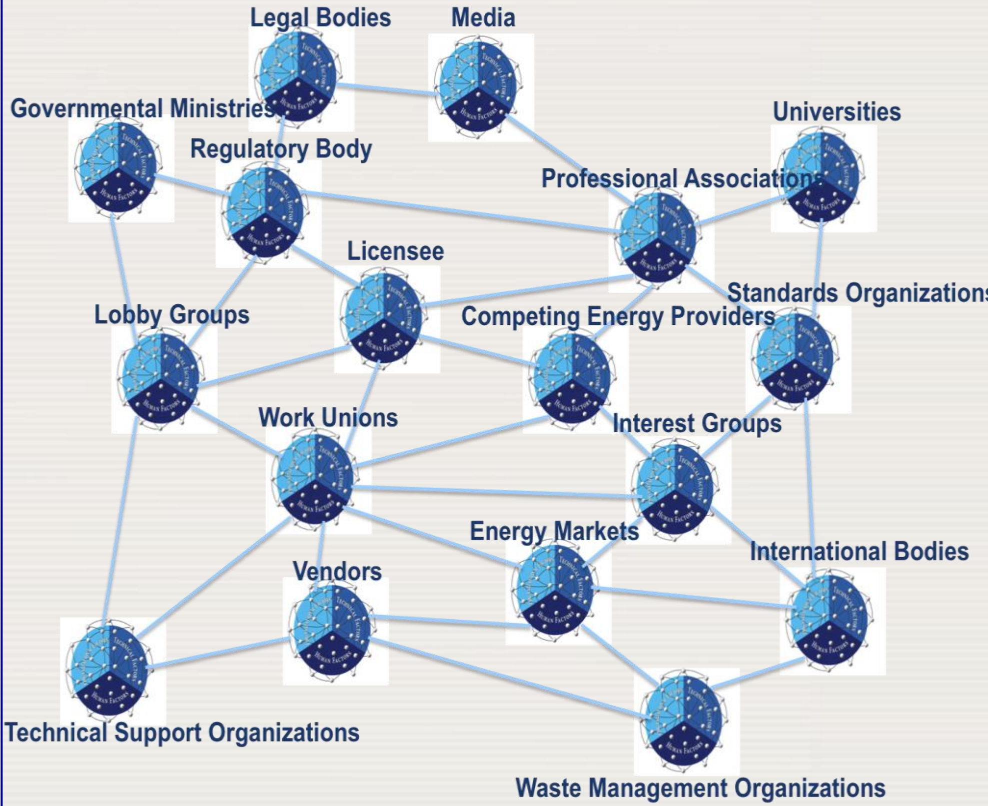


Lessons Learned 4 and 5

Lessons Learned:

4. A systemic approach to safety needs to be taken in event and accident analysis, considering all stakeholders and their interactions over time.

5. To proactively deal with the complexity of nuclear operations, the results of research on complex sociotechnical systems for safety need to be taken into account by all stakeholders involved.



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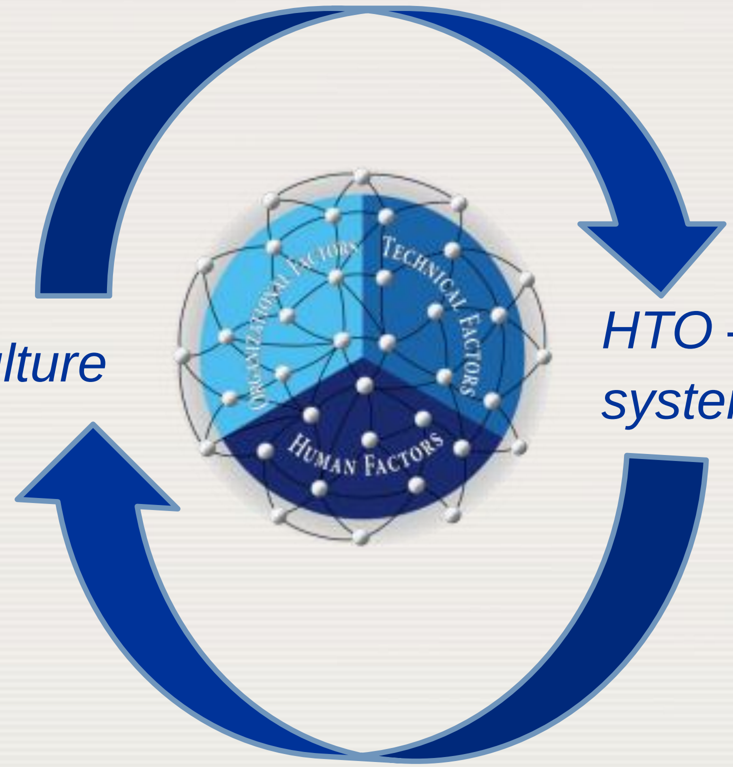
Relation to Safety Culture: Self-reinforcing Dynamics

Strong safety culture



HTO – embraces the systemic interactions

Lessons Learned 6 and 7

6. The regulatory body needs to acknowledge its role within the national nuclear system and the potential for its impact on the nuclear industry's safety culture.

7. Licensees, regulators and governments need to conduct a transparent and informed dialogue with the public on an ongoing basis.

About the results of the Systemic Analysis

- A diversity of approaches :
  - Safety Assessment and,
  - Systemic Analysis

- Comments from the co-chairs of Working Group-2 of the Fukushima Report:

  “HOF Team results based on the Systemic Analysis are aligned with the results from the Safety Assessment and provide further explanations to the current understanding. The methodology used is sound, and it validates the conclusions”

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In Summary

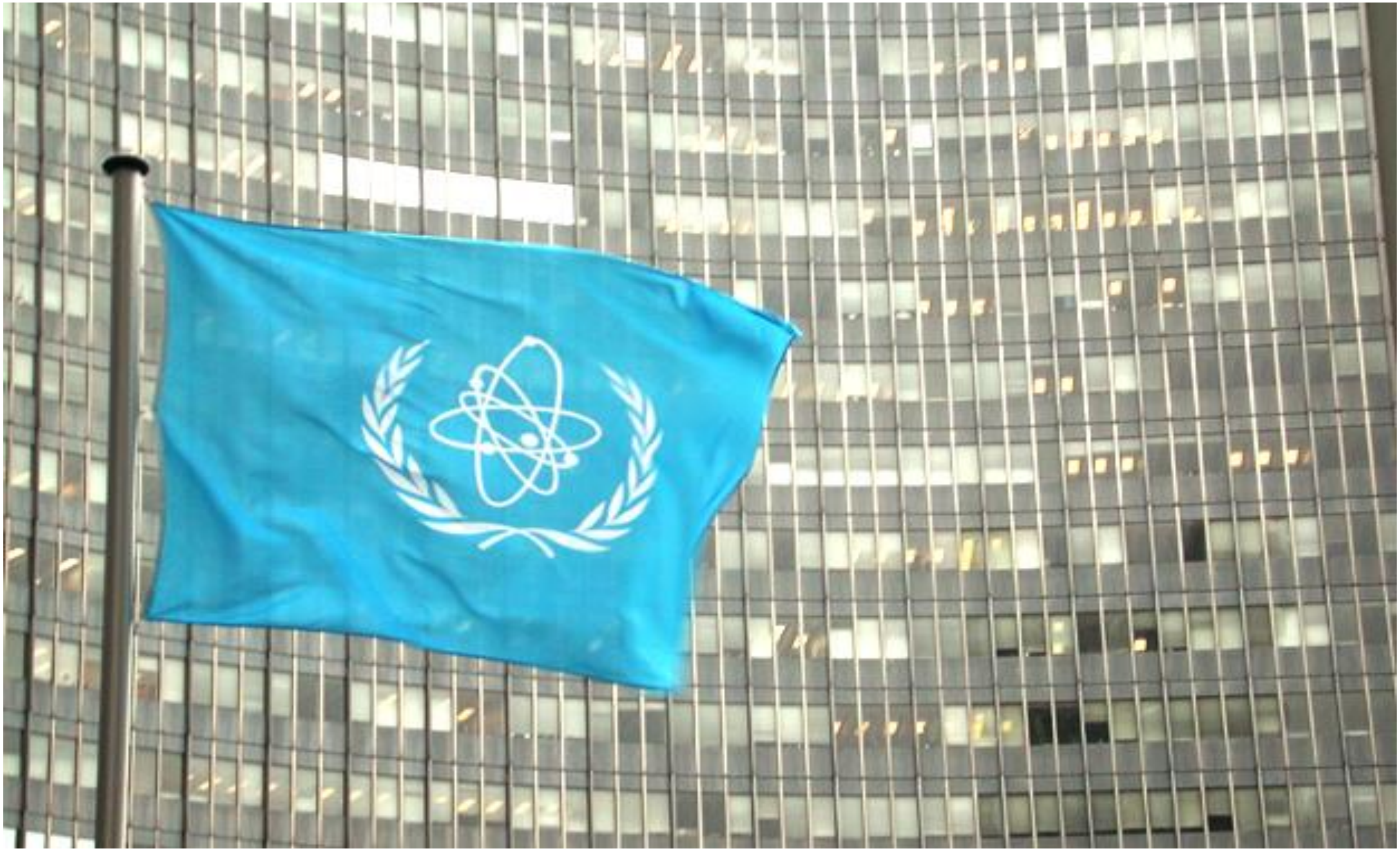
- Systemic Analysis provides a complementary approach to other approaches
- Safety Culture: regularly challenge basic assumptions
- The possibility of the unexpected needs to be integrated into nuclear safety approach
- Prepare for the unexpected
- Take into account harsh complex conditions and unexpected situations into emergency drills and exercises
- Important to consider results of research on complex sociotechnical systems for safety
- Regulatory body needs to acknowledge its role and, impact on the nuclear industry's safety culture
- Transparent and informed dialogue with the public

Final thoughts

"There can be no grounds for complacency about nuclear safety in any country. Some of the factors that contributed to the Fukushima Daiichi accident were not unique to Japan. Continuous questioning and openness to learning from experience are key to safety culture and are essential for everyone involved in nuclear power.

Safety must always come first."

Yukiya Amano, IAEA Director General



Thank you for your attention