Update on CATF Fusion Safety and Regulation Program and Education Courses

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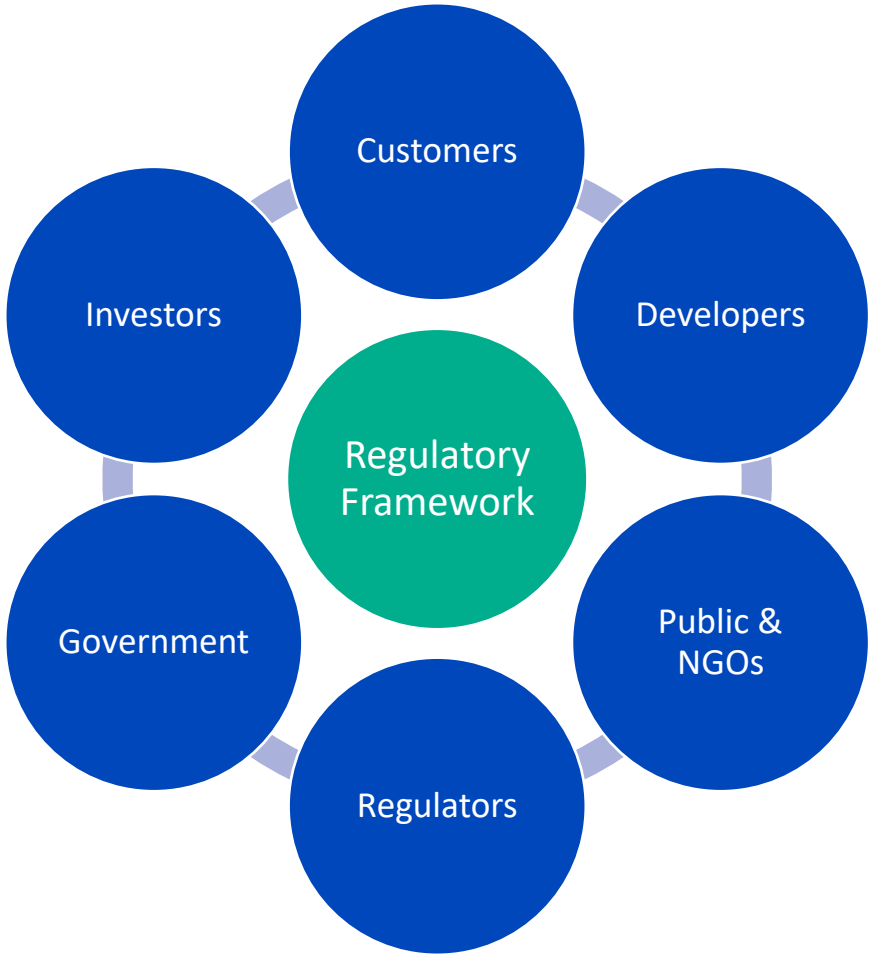
CLEAN AIR TASK FORCE

— CATF Fusion Safety and Regulation Working Group

- Goal: Creating a harmonized framework for safety and regulation for commercial fusion energy that can be adopted internationally and enable the global deployment of fusion energy. This framework must include both public acceptance of fusion energy and commercial viability of the technology.
- Challenge: Varying regulatory needs throughout based on the specific fusion machine, technology lifecycle, and during different stages of commercialization.



— Fusion energy has immense potential, and effective regulation can be aligned to enable development

Commercial Fusion Technology

Creating Fusion Regulations

CATF Fusion Safety Course

— Emerging commercial fusion technology will have a wide variety of different approaches and possible hazards

Commercial Fusion Technology

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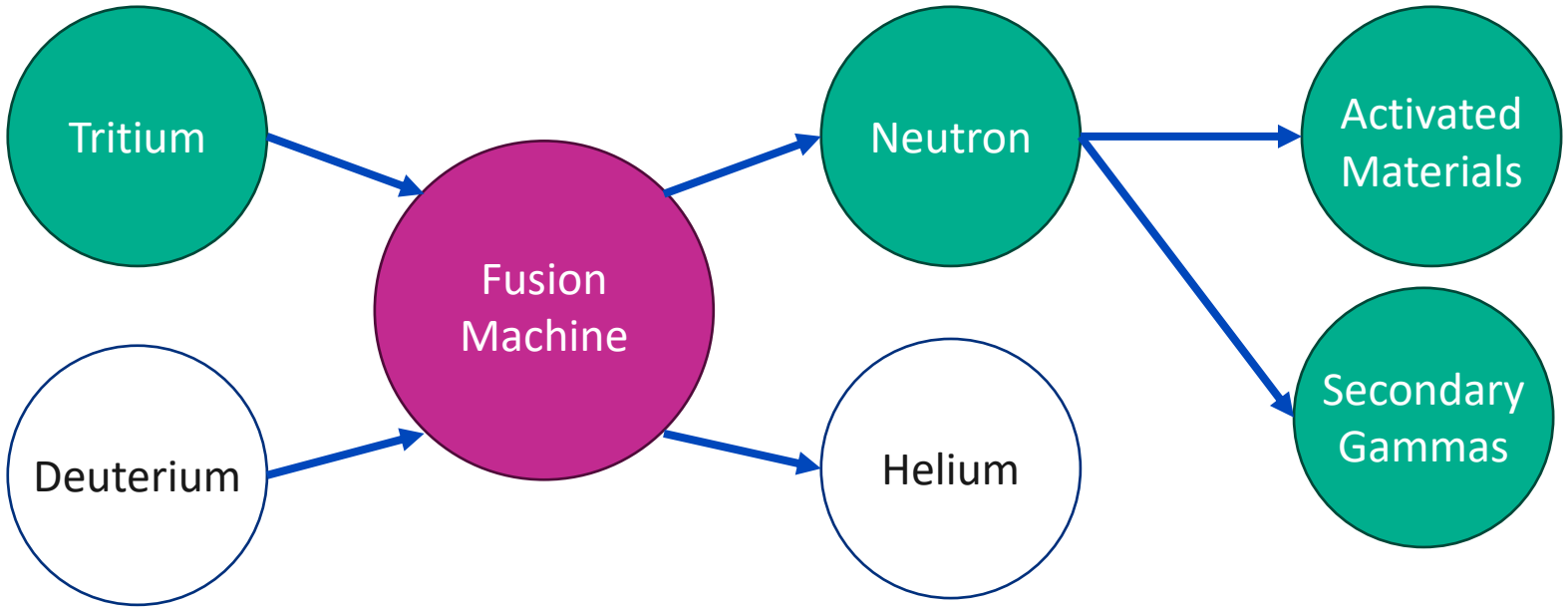
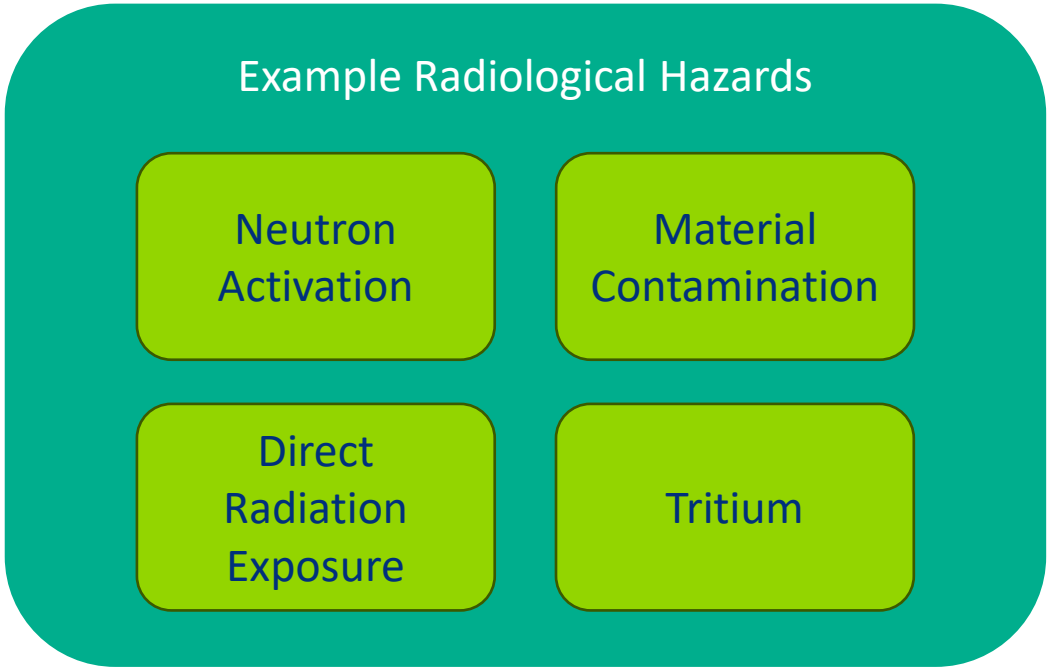
CATF Fusion Safety Course

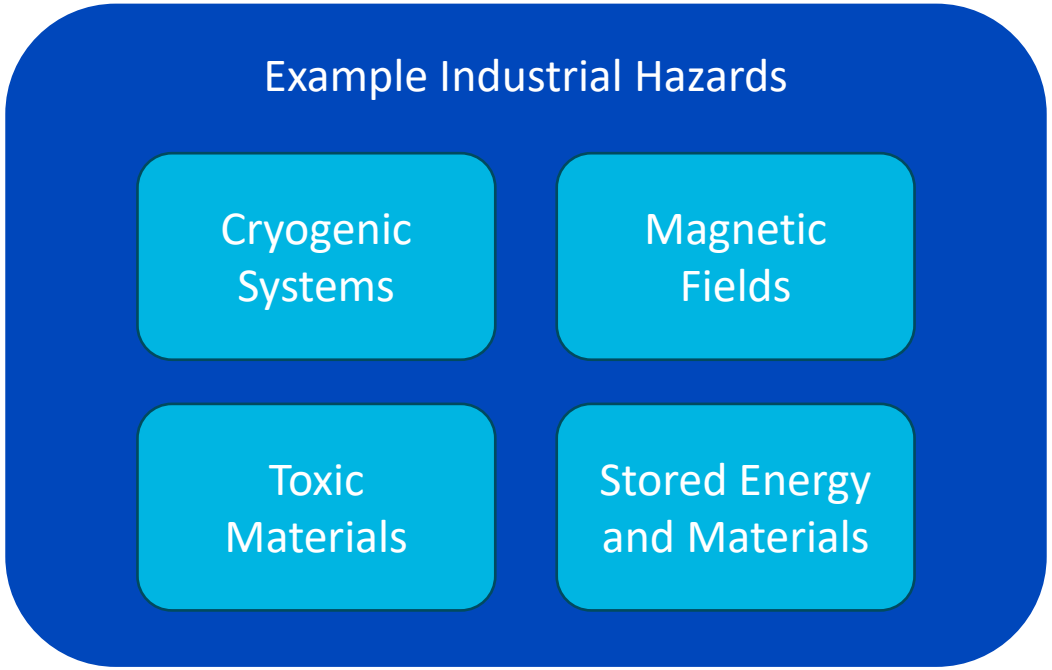
— Fusion power plants will have inherent hazards that may warrant regulatory oversight



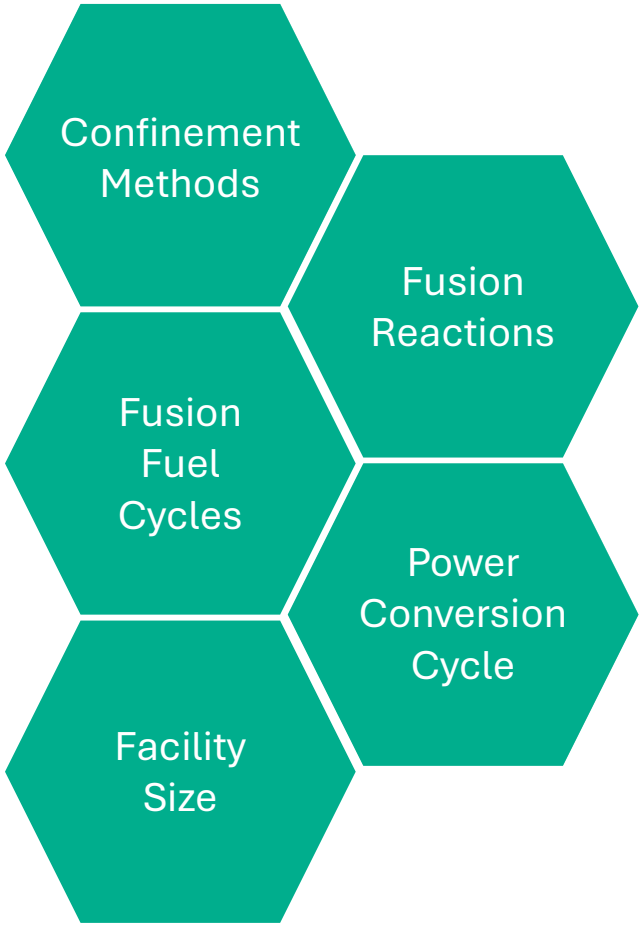
Example: D-T Fusion Radiation Hazards

— Fusion power plants will have inherent hazards that may warrant regulatory oversight





— Fusion regulation is challenging to develop today because the approaches to fusion vary widely



Commonwealth Fusion Systems

AVALANCHE

HELION

TYPE ONE ENERGY

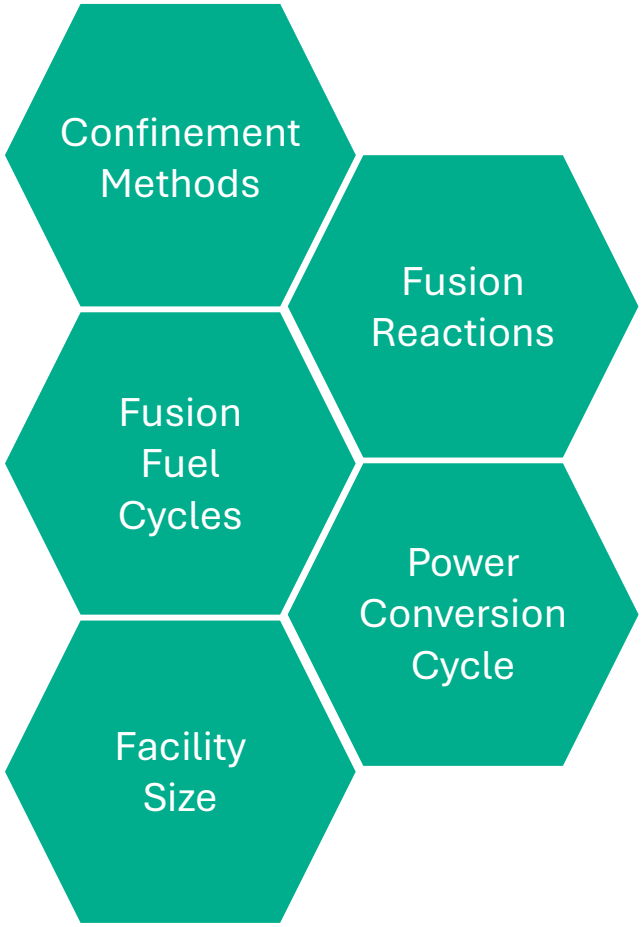
XCIMER

generalfusion

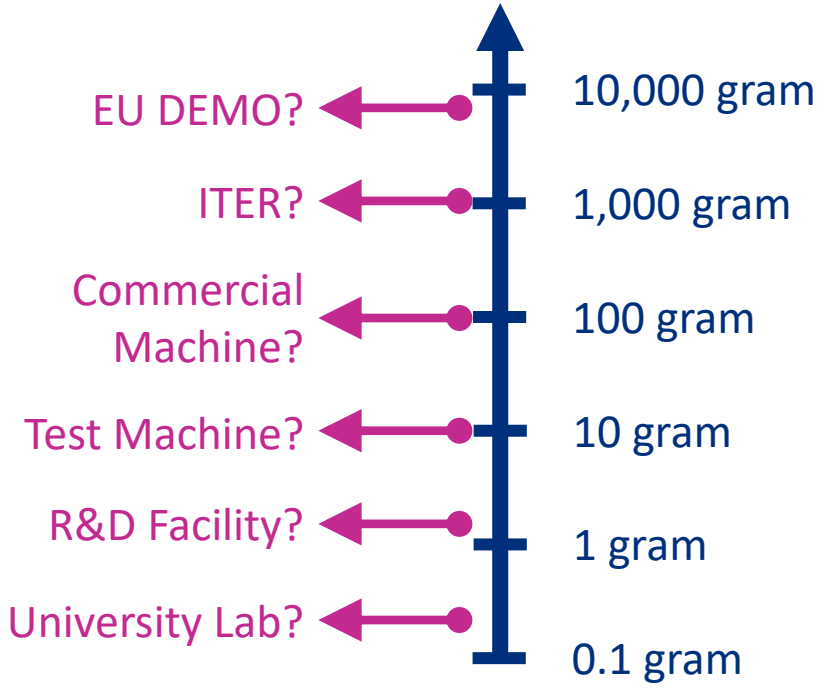
REALTA FUSION

ZAP ENERGY

— Fusion regulation is challenging to develop today because the operations will evolve over time



Example: Regulating tritium hazards



Total Tritium Inventory

Regulatory needs for fusion machines will evolve during fusion energy development and commercialization

Example: Regulatory needs for fusion will evolve over time based on machines purpose, hazards, experience, and industry maturity

Scientific Demonstration Machines	Engineering Demonstration Machines	Commercial Demonstration Machines	Commercial Machines At Scale
$Q_{scientific} > 1$	$Q_{scientific} >> 1$ $Q_{engineering} > 1$	$Q_{engineering} >> 1$	Cost competitive fusion energy

— Effective fusion energy licensing requires proportional, technology-inclusive, and performance-based regulation

Commercial Fusion Technology

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CATF Fusion Safety Course

— Regulation evolves based on technology maturity, industry experience and events, and social and political input

Protected Groups

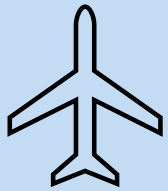
- Workers
- Public
- Environment

Industry Needs

- Flexibility
- Certainty
- Scalability

Public and Political Input

- Accidents and harms
- Activity trade-offs
- Public perceptions



Example: U.S. Aviation

1905 Wright Brothers
- First practical airplane developed and tested

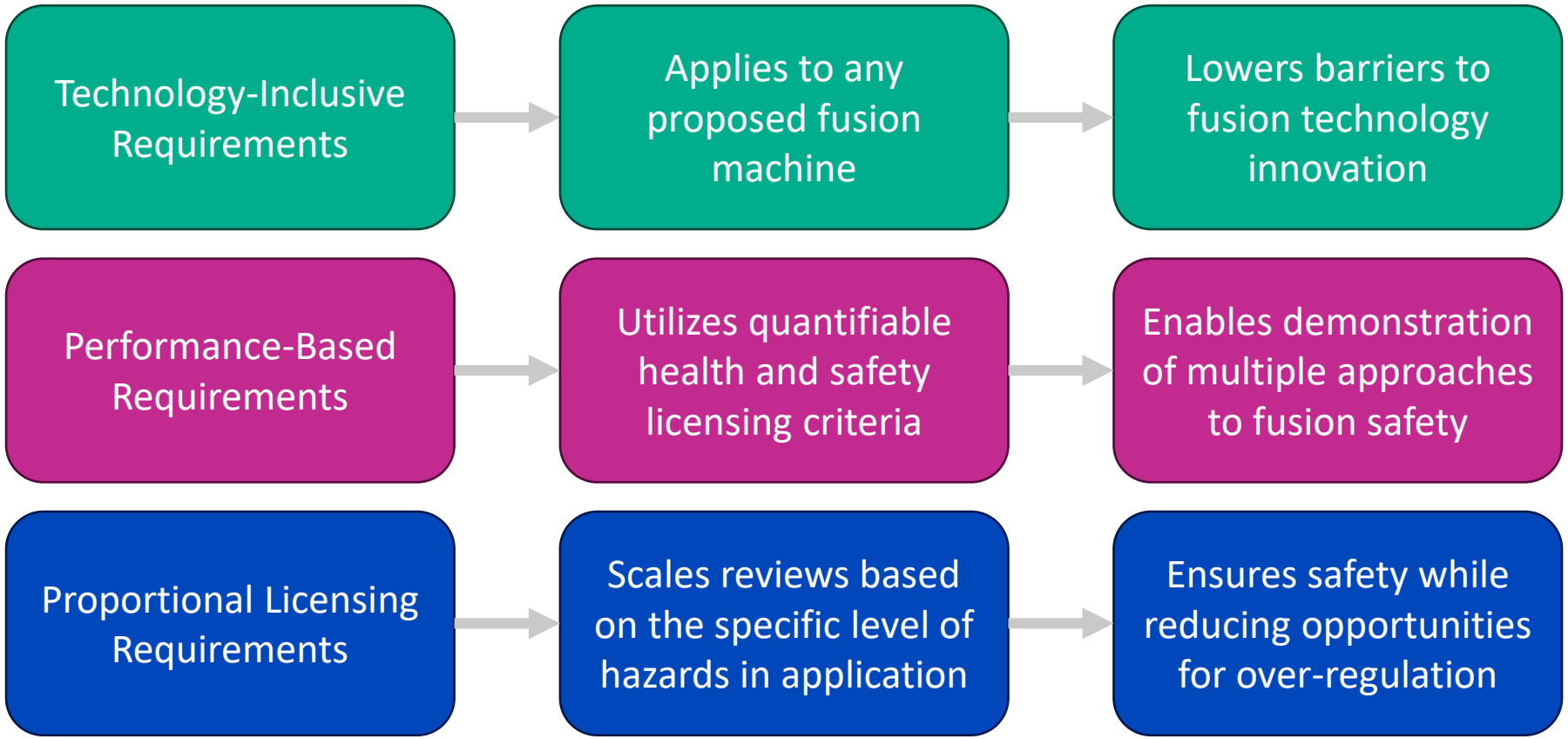
1926 Air Commerce Act
- Need for safety standards
- Emerging industry certainty

1938 Civil Aeronautics Act
- Major aviation accidents
- Maturing industry

1958 Federal Aviation Act
- Major aviation accidents
- Rapidly expanding industry

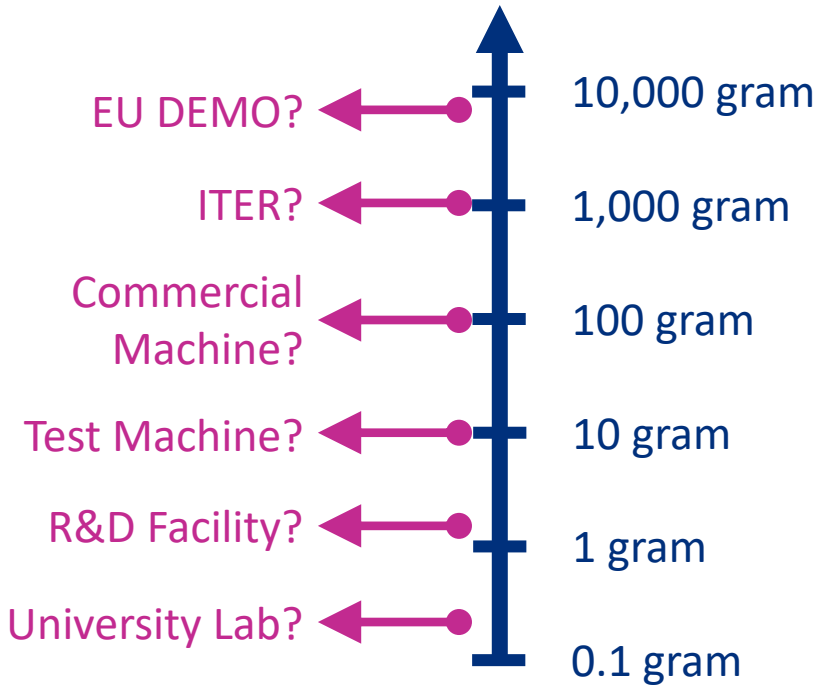
1978 Airline Deregulation Act
- Fully mature industry
- Commercial transition

— Proportional, technology-inclusive, and performance-based regulation enable effective, scalable fusion licensing



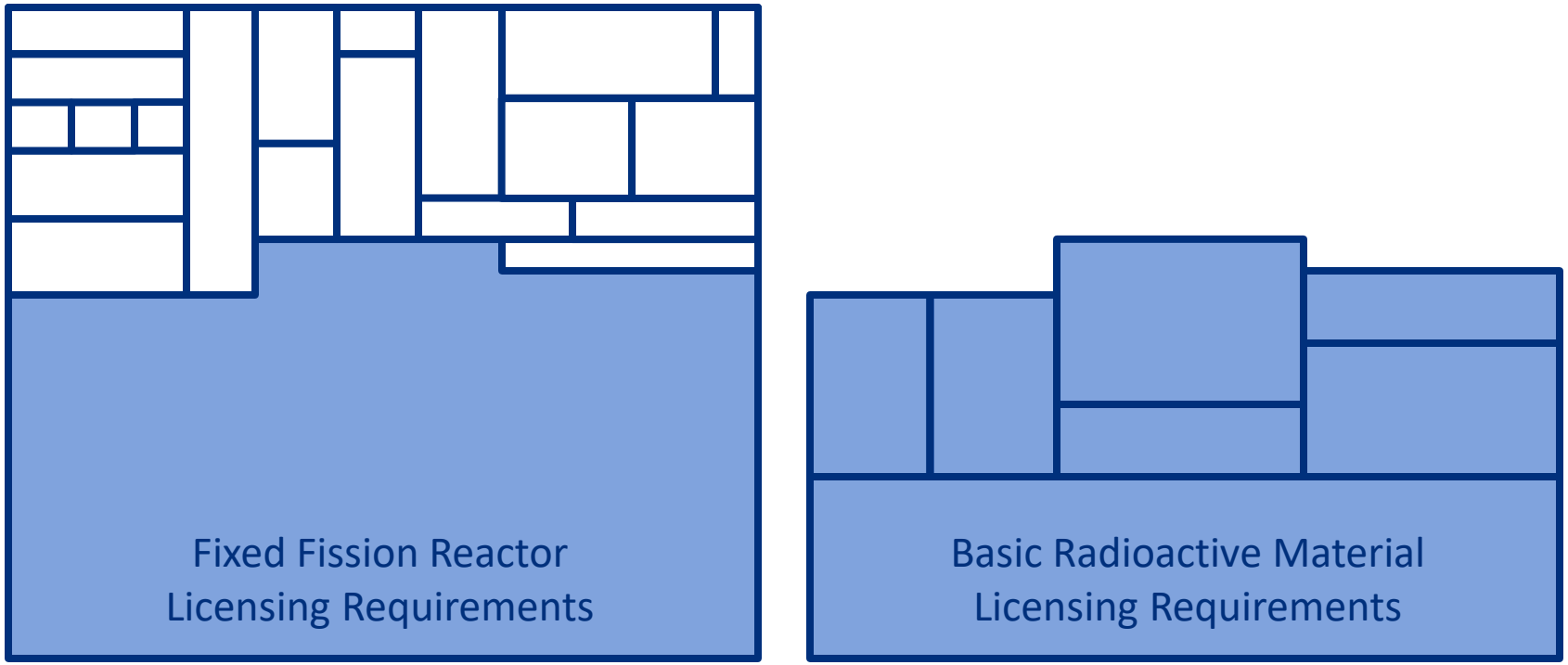
— Proportional licensing requirements enable regulations to scale based on the specific application

Example: Regulating tritium hazards



- Documentation of Licensing Safety Case
- Licensing Analysis of Machine Safety
- Engineered Safety Systems and Operational Safety Programs
- Off-site Emergency Planning and Response Requirements
- Environmental Impact Review and Siting Requirements

— Proportional licensing may be easier to achieve by adding license conditions instead of providing license exemptions



Example illustration of licensing exemptions versus additional license conditions

Proportional fusion regulation based on additional licensing conditions can improve flexibility for fusion regulation and prevent inadvertent focus on fission safety principles

Additional licensing conditions could be significant for fusion machines with large hazard inventories that differ widely from prior regulated activities

— "Near term" fusion energy will be regulated in the United States using byproduct materials framework (10 CFR Part 30)

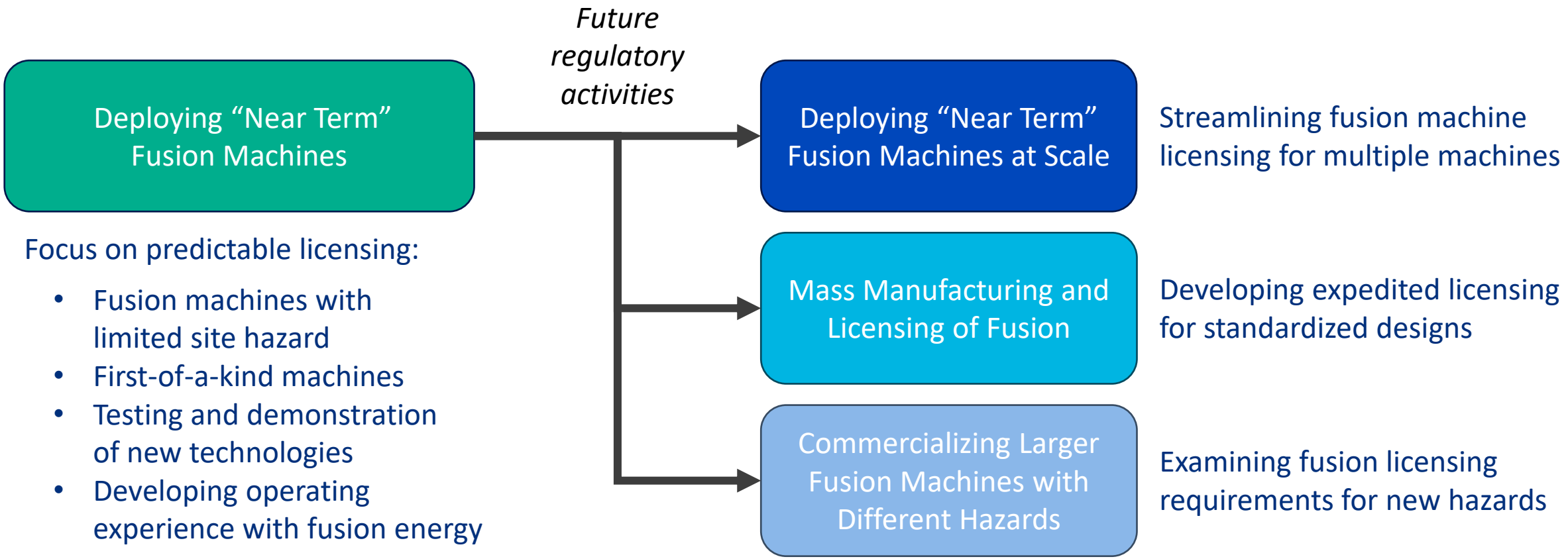
Regulate fusion energy systems under a byproduct material framework

NRC Commission Vote SECY-23-0001

Staff Implementation Actions

- Limited Scope Rulemaking on Fusion Energy Definitions
- Development of Guidance for Fusion Energy in NUREG-1556 Volume 22
- Engagement with NRC Agreement States on Fusion Energy Regulation

— Scalable fusion energy regulation requires the ability to provide near-term certainty and long-term predictability



Focus on predictable licensing:

- Fusion machines with limited site hazard
- First-of-a-kind machines
- Testing and demonstration of new technologies
- Developing operating experience with fusion energy

— CATF is engaging with international stakeholders to build understanding of fusion regulation fundamentals

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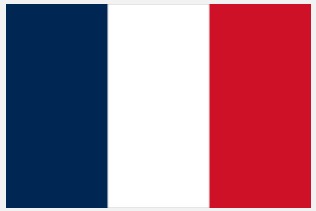
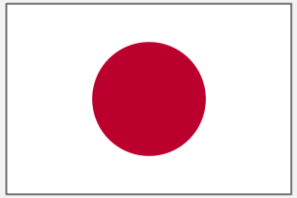
— Regulators around the world are beginning discussions on appropriate regulatory frameworks for fusion energy

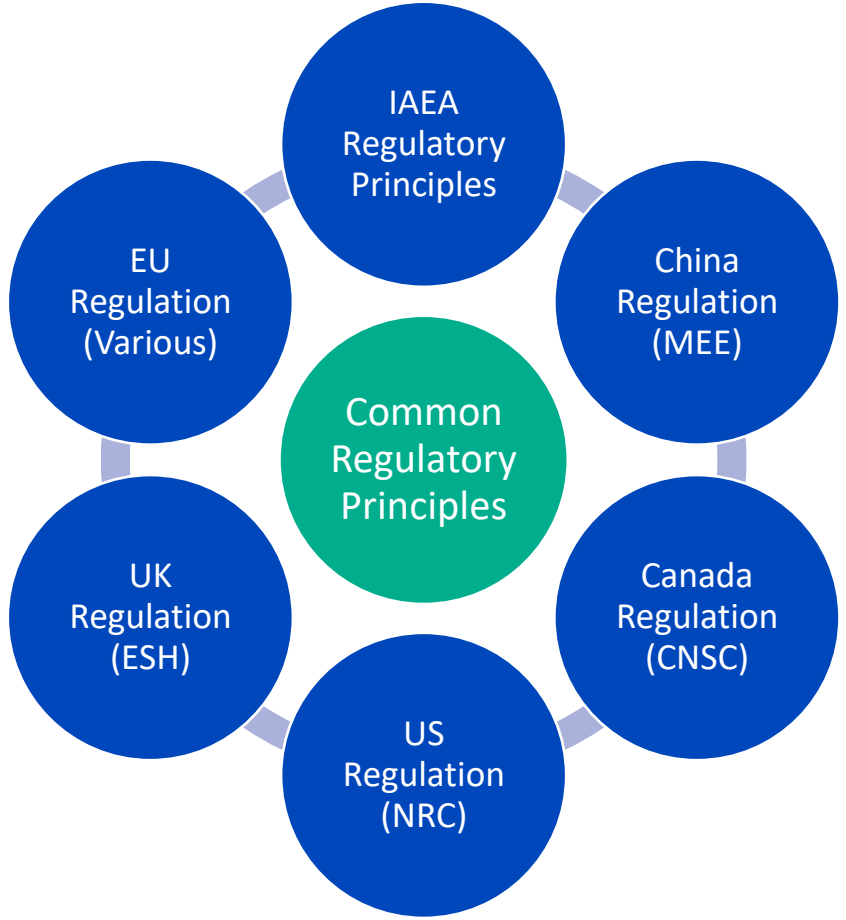
Fusion as Radioactive Material Activities


Fusion as Nuclear Installation



Regulation of Fusion is Still Under Discussion



— CATF identified a need for stakeholders to learn more about the safety and future regulation of fusion energy

Safety Course Goals

- Hear directly from global experts in fusion safety and regulation
- Expand your fusion network across industry, academia, and policy
- Understand the current regulatory environment for commercial fusion
- Learn about key safety considerations as fusion companies move toward pilot plant development

— CATF partnered with MIT Plasma Science and Fusion Center (PSFC) on first offering of Fusion Safety Course

Presented By:

CLEAN AIR TASK FORCE

Plasma Science & Fusion Center

— Course focused on expert lectures and facility case studies to increase stakeholder knowledge of fusion safety

Day 1: Introduction to Fusion Energy and Fusion Safety

- Fusion technology overview
- Fusion power plant design
- Fusion safety considerations
- Design specific hazards
- Industry safety principles

Day 2: Case Studies on Radioactive Material, Accelerator, and Fusion Machine Safety

Safety Case Studies:

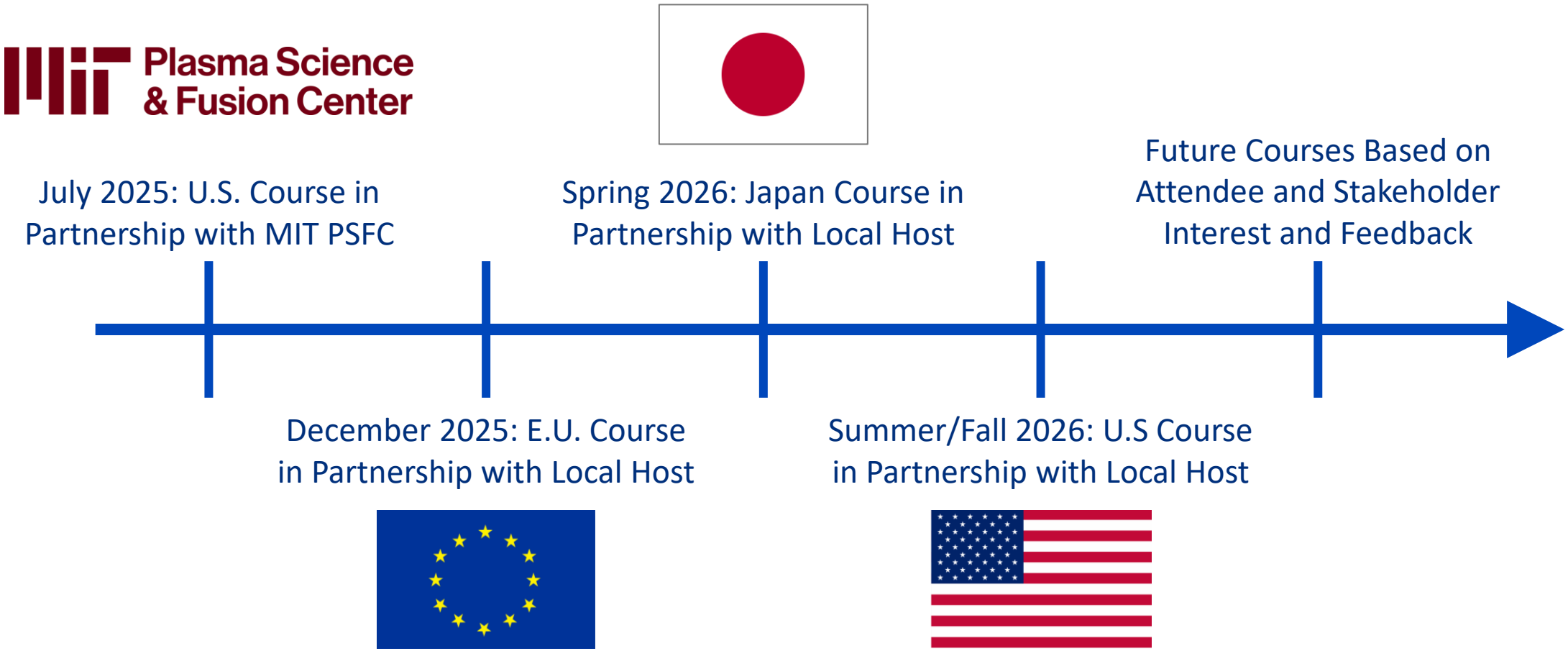
- MIT PSFC Labs
- Savannah River National Lab
- European CERN Facilities
- SHINE Commerical Facility
- EuroFusion and EU Demo
- ITER Experiment
- UKAEA and JET Experiment

Day 3: Considerations for Creating and Implementing Fusion Regulation

- Connecting fusion energy safety and regulation
- U.S. national and state regulations
- International regulatory developments
- Providing regulatory certainty for fusion at scale

Full Agenda and Speakers for CATF/PSFC Fusion Safety and Regulation Course

— CATF is planning future offerings of Fusion Safety and Regulation Course to meet stakeholder interest



— Consensus on fusion regulatory principles and national implementation creates pathways for fusion deployment

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