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Written statement from the CATF Director of the Global Fusion Programme to the Committee on Education, Research and Technology Assessment

Dear Members of the Committee on Education, Research and Technology Assessment

I would like to submit a written statement related to the current hearing on a motion (20/10383) from the CDU/CSU parliamentary group entitled "For a pragmatic, innovation-friendly legal framework for fusion power plants in Germany and Europe".

The development of fusion as a commercial source of energy is the focus of the CATF global Fusion programme and the development of the adequate frameworks for its consecution is an element of paramount importance for it. Other important aspect is the harmonization of those legal frameworks allowing the development of a global industry with a global market.

The CATF Global Fusion programme is in line with these tasks.

Commercial fusion regulation can be examined using a “first principles” paradigm to evaluate different regulatory options. The “first-principles” approach to regulation development allows for a thorough examination of the hazards inherent in fusion technology, delineating acceptable limits for these hazards, and evaluating facilities for compliance with regulatory standards.

The potential hazards of fusion energy may include a variety of radiological and industrial hazards based on the specific fusion technology.

Any radiological hazards of fusion energy will be similar to the radiation sources that are currently safely managed by companies and regulators around the world. These hazards may include radiation produced by certain fusion reactions (neutron and gamma radiation), components and materials in a fusion machine made radioactive or “activated” by neutron radiation, and tritium, a radioactive hydrogen isotope, that is used as fusion fuel and produced as a byproduct in many fusion technologies. Some fusion technologies may also have non-ionization radiation sources such as high-energy lasers and microwaves. The types of radiological hazards that may be present in future fusion energy machines are already managed by companies and regulators around the world for different activities.

Any industrial hazards of fusion energy will be similar to those currently routinely managed by energy and chemical companies. These hazards may include chemically hazardous materials (e.g., beryllium or lead), chemically reactive materials (e.g., lithium or liquid metals), physically hazardous materials (e.g., liquid helium) extremely high temperature or low temperature (cryogenic) systems, systems that contain high pressures or vacuum conditions, extremely strong magnetic fields, and the large electricity generating components such as turbine generators and electrical transformers used in existing power plants. The types of industrial hazards that may be present in future fusion energy are already routinely managed by companies and health and safety organizations around the world.

The specific hazards of fusion energy will depend on the fusion technology and a specific proposed design. No fusion energy technology is expected to have all the hazards described above and some designs may only have a very small number of the radiological and industrial hazards described above. Understanding the potential radiological and industrial hazards of fusion energy and the specific hazards of a proposed fusion technology and design is important to creating a regulatory system that work alongside companies to help ensure the health and safety of workers, the public, and the environment.

Regulatory needs include:

- A technology-inclusive definition of fusion power plant hazards and hazard potentials. Hazards in fusion are most common from radiological inventory releases.
- Development of fusion power plant-specific safety objective and principles. Safety objectives define the organization’s safety priorities that address its most significant safety risks, whereas safety principles apply to the security of facilities and activities. Safety principles could include appropriate provisions in the design and construction of installations, controls on access to installations, arrangements for mitigating the consequences of accidents and failures, and measures for the security of the management of radioactive sources and radioactive material.

- Characterization of a harmonizable fusion power plant safety case where a technical structured argument, supported by clear evidence, justifies that a fusion system is safe for operation.
- Development of fusion power plant regulatory principles that reflect the uniqueness of fusion energy systems to ensure licensees operate their facilities in a safe manner at all times.
- Comparison of possible fusion power plant regulatory approaches.
- Proposal for a harmonizable fusion power plant regulatory framework that allows for the commercialization and safe development of fusion systems.

These considerations will be critical at all lifecycle stages for commercial fusion energy.

A fundamental challenge lies in aligning regulatory frameworks with the unique characteristics of fusion energy. Unlike traditional nuclear fission plants, fusion technology necessitates unique considerations for ensuring working safety, protecting the public and environment from potential hazards, and safeguarding against accidents. While these goals may seem familiar, they are not covered by the current framework of nuclear safety standards. Simply transplanting existing regulatory paradigms would be inadequate and fail to address the distinctive safety targets posed by fusion technology.

CATF has been working to evaluate and catalogue lessons learned from existing regulatory approaches across the globe. This includes a thorough examination of fusion regulation from ITER, headquartered in France, as well as efforts in the United Kingdom, the United States, Germany, Japan and China. Many countries are still focused on ITER/DEMO scale and timeframe, which maintains the expectation that fusion is still decades away. There are emerging private sector players offering fusion solutions that could become viable much sooner than ITER.

The lack of an internationally recognized framework for fusion regulation leaves private fusion developers in a state of uncertainty and grappling with the ambiguity of compliance requirements. So far, the UK and the U.S. have been early movers in establishing commercial fusion regulations, with both codifying in law the approach to be taken. Both countries have endorsed non-fission approaches to regulating fusion plants and are aligning fusion with regulatory frameworks applied to byproduct, industrial and medical materials. Other countries are expected to follow suit. As recently stated in the country's first Fusion Day, Canada is expected to follow this trajectory, but national legislation may be required. Similarly, Japan has announced intent to move forward under National Strategy, but the formulation of regulations is not anticipated for at least one to two years.

Most of the data required to validate the safety analyses comes from existing databases from previous fusion facilities. However, some of this data can only be checked during operation and during the progressive start-up of a facility. Consequently, ongoing needs will persist through the deployment and operation of the first series of fusion plants.

When done properly, the licensing costs should be covered by the normal investment protection program. To facilitate this, it is essential to employ a meticulous selection and utilization of codes and standards based on a graded risk approach. This approach not only provides clarity for private companies, but also ensures the implementation of an appropriate quality management program that meets the expectations of regulatory bodies.

CATF is committed to aiding the development of appropriate fusion regulatory frameworks by providing and undertaking the following:

- Establishing fusion definitions and safety principles
- Developing regulatory principles to inform the key characteristics needed to help countries to develop fusion power plant specific regulatory frameworks for safety, security, safeguards and the management of radioactive waste.
- Assisting in the creation of a harmonized regulatory framework for fusion that enables a global market.

Despite the safety targets posed by the diversity of fusion technologies and the early stages of various designs, the global deployment of fusion energy necessitates the establishment of robust regulatory frameworks. CATF remains dedicated to continuing to inform these frameworks to effectively address the safety, environment, and non-proliferation concerns associated with fusion power plants.