(B) the effectiveness of the coordination and management of the program; and

(C) the implementation of the research plan outlined in paragraph (3).

(6)[1] Definitions

In this subsection:

(A) Low-dose radiation

The term ''low-dose radiation'' means a radiation dose of less than 100 millisieverts.

(B) Low dose-rate radiation

The term ''low dose-rate radiation'' means a radiation dose rate of less than 5 millisieverts per hour.

(7) Rule of construction

Nothing in this subsection shall be construed to subject any research carried out by the Secretary for the program under this subsection to any limitations described in section 16317(e) of this title.

(8) Funding

For purposes of carrying out this subsection, the Secretary is authorized to make available from funds provided to the Biological and Environmental Research Program—

(A) $20,000,000 for fiscal year 2021;

(B) $20,000,000 for fiscal year 2022;

(C) $30,000,000 for fiscal year 2023; and

(D) $40,000,000 for fiscal year 2024.

(d) Space radiation research

The Secretary of Energy, shall continue and strengthen collaboration with the Administrator of the National Aeronautics and Space Administration on basic research to understand the effects and risks of human exposure to ionizing radiation in low Earth orbit, and in the space environment.

(Pub. L. 115–246, title III, § 306, Sept. 28, 2018, 132 Stat. 3148; Pub. L. 116–260, div. Z, title XI, § 11001, Dec. 27, 2020, 134 Stat. 2610.)

Editorial Notes

REFERENCES IN TEXT

Section 106(b) of the American Innovation and Competitiveness Act (42 U.S.C. 6601 note), referred to in subsec. (c)(2)(A), is section 106(b) of Pub. L. 114–329, title I, Jan. 6, 2017, 130 Stat. 2986, which is set out in a note under section 6601 of this title.

AMENDMENTS

2020—Subsec. (c). Pub. L. 116–260, § 11001(a), amended subsec. (c) generally. Prior to amendment, subsec. (c) related to the establishment and purpose of a low-dose radiation research program.

Subsec. (d). Pub. L. 116–260, § 11001(b), added subsec. (d).

§ 18645. Fusion energy

(a) Program

As part of the activities authorized under section 7139 of this title and section 16312 of this title, the Director shall carry out a fusion energy sciences research and enabling technology development program to effectively address the scientific and engineering challenges to building a cost competitive fusion power plant and to support the development of a competitive fusion power industry in the United States. As part of this program, the Director shall carry out research activities to expand the fundamental understandings of plasma and matter at very high temperatures and densities for fusion applications and for other engineering and plasma science applications.

(b) Fusion materials research and development

As part of the activities authorized in section 16318 of this title—

(1) the Director, in coordination with the Assistant Secretary for Nuclear Energy of the Department, shall carry out research and development activities to identify, characterize, and demonstrate materials that can endure the neutron, plasma, and heat fluxes expected in a fusion power system; and

(2) the Director shall provide an assessment of—

(A) the need for one or more facilities that can examine and test potential fusion and next generation fission materials and other enabling technologies relevant to the development of fusion power; and

(B) whether a single new facility that substantially addresses magnetic fusion and next generation fission materials research needs is feasible, in conjunction with the expected capabilities of facilities operational as of September 28, 2018.

(c) Tokamak research and development

The Director shall support research and development activities and facility operations to optimize the tokamak approach to fusion energy.

(d) Inertial fusion research and development

(1) In general

The Director shall carry out a program of research and technology development in inertial fusion for energy applications, including ion beam, laser, and pulsed power fusion systems.

(2) Activities

As part of the program described in paragraph (1), the Director shall support activities at and partnerships with universities and the National Laboratories to—

(A) develop novel target designs;

(B) support modeling of various inertial fusion energy concepts and systems;

(C) develop diagnostic tools; and

(D) improve inertial fusion energy driver technologies.

(3) Authorization of appropriations

Out of funds authorized to be appropriated under subsection (*o*), there are authorized to be appropriated to the Secretary to carry out the activities described in subsection (d) $25,000,000 for each of fiscal years 2021 through 2025.

(e) Alternative and enabling concepts

(1) In general

The Director shall support research and development activities and facility operations at institutions of higher education, National Laboratories, and private facilities in the

[1] So in original. No par. (5) has been enacted.

United States for a portfolio of alternative and enabling fusion energy concepts that may provide solutions to significant challenges to the establishment of a commercial magnetic fusion power plant, prioritized based on the ability of the United States to play a leadership role in the international fusion research community.

(2) Activities

Fusion energy concepts and activities explored under paragraph (1) may include—

(A) alternative fusion energy concepts, including—

(i) advanced stellarator concepts;

(ii) non-tokamak confinement configurations operating at low magnetic fields;

(iii) magnetized target fusion energy concepts; or

(iv) other promising fusion energy concepts identified by the Director;

(B) enabling fusion technology development activities, including—

(i) high magnetic field approaches facilitated by high temperature superconductors;

(ii) liquid metals to address issues associated with fusion plasma interactions with the inner wall of the encasing device; and

(iii) advanced blankets for heat management and fuel breeding; and

(C) advanced scientific computing activities.

(3) Innovation network for fusion energy

(A) In general

The Secretary, acting through the Office of Science, shall support a program to provide fusion energy researchers with access to scientific and technical resources and expertise at facilities supported by the Department, including such facilities at National Laboratories and universities, to advance innovative fusion energy technologies toward commercial application.

(B) Awards

Financial assistance under the program established in subsection (a)—

(i) shall be awarded on a competitive, merit-reviewed basis; and

(ii) may be in the form of grants, vouchers, equipment loans, or contracts to private entities.

(4) Authorization of appropriations

Out of funds authorized to be appropriated under subsection (*o*), there are authorized to be appropriated to the Secretary to carry out the activities described in subsection (e) $50,000,000 for each of fiscal years 2021 through 2025.

(f) Coordination with ARPA–E

The Director shall coordinate with the Director of the Advanced Research Projects Agency-Energy (referred to in this subsection as ''ARPA–E'') to—

(1) assess the potential for any fusion energy project supported by ARPA–E to represent a promising approach to a commercially viable fusion power plant;

(2) determine whether the results of any fusion energy project supported by ARPA–E merit the support of follow-on research activities carried out by the Office of Science; and

(3) avoid the unintentional duplication of activities.

(g) Omitted

(h) Identification of priorities

(1) Report

(A) In general

Not later than 2 years after September 28, 2018, the Secretary shall submit to Congress a report on the fusion energy research and development activities that the Department proposes to carry out over the 10-year period following the date of the report under not fewer than 3 realistic budget scenarios, including a scenario based on 3-percent annual growth in the non-ITER portion of the budget for fusion energy research and development activities.

(B) Inclusions

The report required under subparagraph (A) shall—

(i) identify specific areas of fusion energy research and enabling technology development in which the United States can and should establish or solidify a lead in the global fusion energy development effort;

(ii) identify priorities for initiation of facility construction and facility decommissioning under each of the three budget scenarios described in subparagraph (A); and

(iii) assess the ability of the fusion workforce of the United States to carry out the activities identified under clauses (i) and (ii), including the adequacy of programs at institutions of higher education in the United States to train the leaders and workers of the next generation of fusion energy researchers.

(2) Process

In order to develop the report required under paragraph (1)(A), the Secretary shall leverage best practices and lessons learned from the process used to develop the most recent report of the Particle Physics Project Prioritization Panel of the High Energy Physics Advisory Panel.

(3) Requirement

No member of the Fusion Energy Sciences Advisory Committee shall be excluded from participating in developing or voting on final approval of the report required under paragraph (1)(A).

(i) Milestone-based development program

(1) In general

Using the authority of the Secretary under section 7256(g) of this title, notwithstanding paragraph (10) of such section, the Secretary shall establish, not later than 6 months after the date of enactment of this section, a milestone-based fusion energy development pro-

gram that requires projects to meet particular technical milestones before a participant is awarded funds by the Department.

(2) Purpose

The purpose of the program established by paragraph (1) shall be to support the development of a U.S.-based fusion power industry through the research and development of technologies that will enable the construction of new full-scale fusion systems capable of demonstrating significant improvements in the performance of such systems, as defined by the Secretary, within 10 years of the enactment of this section.

(3) Eligibility

Any entity is eligible to participate in the program provided that the Secretary has deemed it as having the necessary resources and expertise.

(4) Requirements

In carrying out the milestone-based program under paragraph (1), the Secretary shall, for each relevant project—

(A) request proposals from eligible entities, as determined by the Secretary, that include proposed technical milestones, including estimated project timelines and total costs;

(B) set milestones based on a rigorous technical review process;

(C) award funding of a predetermined amount to projects that successfully meet proposed milestones under paragraph (1), or for expenses deemed reimbursable by the Secretary, in accordance with terms negotiated for an individual award; and

(D) communicate regularly with selected eligible entities and, if the Secretary deems appropriate, exercise small amounts of flexibility for technical milestones as projects mature.

(5) Awards

For the program established under paragraph (1)—

(A) an award recipient shall be responsible for all costs until milestones are achieved, or reimbursable expenses are reviewed and verified by the Department;

(B) should an awardee not meet the milestones described in paragraph (4), the Secretary may end the partnership with an award recipient and use the remaining funds in the ended agreement for new or existing projects carried out under this section; and

(C) consistent with the existing authorities of the Department, the Secretary may end the partnership with an award recipient for cause during the performance period.

(6) Applications

Any project proposal submitted to the program under paragraph (1) shall be evaluated based upon its scientific, technical, and business merits through a peer-review process, which shall include reviewers with appropriate expertise from the private sector, the investment community, and experts in the science and engineering of fusion and plasma physics.

(7) Project management

In carrying out projects under this program and assessing the completion of their milestones in accordance with paragraph (4), the Secretary shall consult with experts that represent diverse perspectives and professional experiences, including those from the private sector, to ensure a complete and thorough review.

(8) Programmatic review

Not later than 4 years after the Secretary has established 3 milestones under this program, the Secretary shall enter into a contractual arrangement with the National Academy of Sciences to review and provide a report describing the findings of this review to the House Committee on Science, Space, and Technology and the Senate Committee on Energy and Natural Resources on the program established under this paragraph (1) that assesses—

(A) the benefits and drawbacks of a milestone-based fusion program as compared to traditional program structure funding models at the Department;

(B) lessons-learned from program operations; and

(C) any other matters the Secretary determines regarding the program.

(9) Annual report

As part of the annual budget request submitted for each fiscal year, the Secretary shall provide the House Committee on Science, Space, and Technology and the Senate Committee on Energy and Natural Resources a report describing partnerships supported by the program established under paragraph (1) during the previous fiscal year.

(10) Authorization of appropriations

Out of funds authorized to be appropriated under subsection (*o*), there are authorized to be appropriated to the Secretary to carry out the activities described in subsection (i), to remain available until expended—

(A) $45,000,000 for fiscal year 2021;

(B) $65,000,000 for fiscal year 2022;

(C) $105,000,000 for fiscal year 2023;

(D) $65,000,000 for fiscal year 2024; and

(E) $45,000,000 for fiscal year 2025.

(j) Fusion reactor system design

The Director shall support research and development activities to design future fusion reactor systems and examine and address the technical drivers for the cost of these systems.

(k) General plasma science and applications

The Director shall support research in general plasma science and high energy density physics that advance the understanding of the scientific community of fundamental properties and complex behavior of matter to control and manipulate plasmas for a broad range of applications, including support for research relevant to advancements in chip manufacturing and microelectronics.

***(l)* Sense of Congress**

It is the sense of Congress that the United States should support a robust, diverse program

in addition to providing sufficient support to, at a minimum, meet its commitments to ITER and maintain the schedule of the project as determined by the Secretary in coordination with the ITER Organization at the time of the enactment of this section. It is further the sense of Congress that developing the scientific basis for fusion, providing research results key to the success of ITER, and training the next generation of fusion scientists are of critical importance to the United States and should in no way be diminished by participation of the United States in the ITER project.

(m) International collaboration

The Director shall—

(1) as practicable and in coordination with other appropriate Federal agencies as necessary, ensure the access of United States researchers to the most advanced fusion research facilities and research capabilities in the world, including ITER;

(2) to the maximum extent practicable, continue to leverage United States participation ITER,[1] and prioritize expanding international partnerships and investments in current and future fusion research facilities within the United States; and

(3) to the maximum extent practicable, prioritize engagement in collaborative efforts in support of future international facilities that would provide access to the most advanced fusion research facilities in the world to United States researchers.

(n) Fission and fusion research coordination report

(1) In general

Not later than 6 months after the date of enactment of this section, the Secretary shall transmit to Congress a report addressing opportunities for coordinating fusion energy research and development activities between the Office of Nuclear Energy, the Office of Science, and the Advanced Research Projects Agency—Energy.

(2) Components

The report shall assess opportunities for collaboration on research and development of—

(A) liquid metals to address issues associated with fusion plasma interactions with the inner wall of the encasing device and other components within the reactor;

(B) immersion blankets for heat management and fuel breeding;

(C) technologies and methods for instrumentation and control;

(D) computational methods and codes for system operation and maintenance;

(E) codes and standard development;

(F) radioactive waste handling;

(G) radiological safety;

(H) potential for non-electricity generation applications; and

(I) any other overlapping priority as identified by the Director of the Office of Science or the Assistant Secretary of Energy for Nuclear Energy.

[1] So in original.

***(o)* Authorization of appropriations**

There are authorized to be appropriated to the Secretary to carry out the activities described in this section—

(1) $996,000,000 for fiscal year 2021;
(2) $921,000,000 for fiscal year 2022;
(3) $961,000,000 for fiscal year 2023;
(4) $921,000,000 for fiscal year 2024; and
(5) $901,000,000 for fiscal year 2025.

(Pub. L. 115–246, title III, § 307, Sept. 28, 2018, 132 Stat. 3148; Pub. L. 116–260, div. Z, title II, § 2008(a), Dec. 27, 2020, 134 Stat. 2474.)

Editorial Notes

REFERENCES IN TEXT

The date of enactment of this section, referred to in subsecs. (i)(1) and (n)(1), probably means the date of enactment of Pub. L. 116—260, which enacted subsecs. (i) and (n) of this section and was approved Dec. 27, 2020.

The enactment of this section, referred to in subsecs. (i)(2) and (*l*), probably means the enactment of Pub. L. 116—260, which enacted subsecs. (i) and (*l*) of this section and made other amendments to this section.

CODIFICATION

Section is comprised of section 307 of Pub. L. 115–246. Subsec. (g) of section 307 of Pub. L. 115–246 amended section 2053 of this title.

AMENDMENTS

2020—Subsec. (a). Pub. L. 116–260, § 2008(a)(2), added subsec. (a). Former subsec. (a) redesignated (b).

Subsecs. (b), (c). Pub. L. 116–260, § 2008(a)(1), redesignated subsecs. (a) and (b) as (b) and (c), respectively. Former subsec. (c) redesignated (d).

Subsec. (d). Pub. L. 116–260, § 2008(a)(3), amended subsec. (d) generally. Prior to amendment, text read as follows: ''The Director shall support research and development activities for inertial fusion for energy applications.''

Pub. L. 116–260, § 2008(a)(1), redesignated subsec. (c) as (d). Former subsec. (d) redesignated (e).

Subsec. (e). Pub. L. 116–260, § 2008(a)(4), amended subsec. (e) generally. Prior to amendment, text read as follows: ''The Director shall support research and development activities and facility operations at institutions of higher education, National Laboratories, and private facilities in the United States for a portfolio of alternative and enabling fusion energy concepts that may provide solutions to significant challenges to the establishment of a commercial magnetic fusion power plant, prioritized based on the ability of the United States to play a leadership role in the international fusion research community.''

Pub. L. 116–260, § 2008(a)(1), redesignated subsec. (d) as (e). Former subsec. (e) redesignated (f).

Subsecs. (f) to (h). Pub. L. 116–260, § 2008(a)(1), redesignated subsecs. (f) and (g) as (g) and (h), respectively.

Subsecs. (i) to (*o*). Pub. L. 116–260, § 2008(a)(5), added subsecs. (i) to (*o*).

§ 18646. Isotope development and production for research applications

The Director—

(1) may carry out a program for the production of isotopes, including the development of techniques to produce isotopes, that the Secretary determines are needed for research, medical, industrial, or related purposes; and

(2) shall ensure that isotope production activities carried out under the program under this paragraph do not compete with private industry unless the Director determines that