July 27, 2018

Dr. Courtney Silverthorn, Deputy Director
Technology Partnerships Office
National Institute of Standards and Technology
100 Bureau Drive MS 2201
Gaithersburg, MD 20899

RE: RFI Response: Federal Technology Transfer Authorities and Processes (Federal Register May 1, 2018, page 19052)

Dear Dr. Silverthorn:

We appreciate this opportunity to provide comments on the benefits of federal investments in basic and applied research, drawn from our role in the management and operations of the Thomas Jefferson National Accelerator Facility (Jefferson Lab), a DOE FFRDC National Laboratory; collaborative research efforts at four NASA centers; working with (or at) NOAA and NSF; participation in intellectual property studies at the National Academy of Sciences; and as the industry partner in CRADAs with five government laboratories.

In Part I we provide information about our own technology transfer activities and our observations of others. We summarize the features of various technology transfer authorities that we believe to be relevant to the Request for Information in Part II. Part III addresses the specific questions raised in the Request for Information.

For your convenience, links to the cited dissertation, Congressional Reports, and conference abstracts are included in the footnotes.

We can be reached at drew@jlab.org, rmoy@sura.org, or 202-657-6202 if you require additional information.

Sincerely,

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Federal Technology Transfer Authorities and Processes

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Part I.

We hesitate to characterize this analysis as 'return on investment' (ROI), which is defined as the ratio of net benefits to costs because a meaningful valuation analysis must also include time and risk.[3] Research valuation is difficult because benefits are often unanticipated or unforeseen and may not be realized until the distant future. An example is Albert Einstein's work on *relativity* more than a century ago to explain the relationship of space, time, and gravity. The first patented technology from this research came not from the former patent examiner, presumably because he did not envision an immediate commercial application. It was an invention of Ernest Lawrence for the particle accelerator,[4] an instrument now extensively used in research, materials processing, and medicine, including proton beam cancer therapies.[5]

The first consumer product based on *relativity* is the Global Positioning System, patented in 1970.[6] GPS operates by calculating position and altitude from the slight time differences synchronized signals are received from clocks on satellites. Correction for 'Einstein's relativistic clock shift'[7] is required because the movement of the satellites

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[3] Hakan Erdogmus, John Favaro, Wolfgan Strigel, *Return on Investment*, IEEE SOFTWARE, p. 18 at 19, May/June 2004.

[4] Ernest O. Lawrence, *Method and Apparatus for the Acceleration of Ions*, UNITED STATES PATENT 1,948,384, February 20, 1934.

[5] See e.g., Andrew G. Weisenberger, *Applications of Nuclear and Particle Physics Technology: Particles & Detection — A Brief Overview*, 21st Particles and Nuclei International Conference (PANIC 2017) International Journal of Modern Physics: Conference Series Vol. 46 (2018); available at https://www.worldscientific.com/doi/pdf/10.1142/S201019451860008X

[6] Roger L. Easton, *Navigation System Using Satellites and Passive Ranging Techniques*, United States Patent 3,789,409, January 29, 1970.

[7] Roger L. Easton, James A. Buisson, Thomas B. McCaskill, O.J. Oaks, Sarah Stebbins, and Marie Jeffries, *The Contribution of Navigation Technology Satellites to the Global Positioning System, Naval Research Laboratory*, NRL Report 8360, December 28, 1979; available at http://www.dtic.mil/dtic/tr/fulltext/u2/a080548.pdf.

through space and their gravitational differences *relative* to an earth receiver affects the perceived timing of the atomic clocks on the satellites *relative* to each other and those on the earth. "GPS satellites are affected by *relativity* in seven different ways."[8]

Basic Research and Technology Transfer Opportunities

The particle accelerator and GPS systems are examples of unanticipated and unforeseen benefits of *relativity* research and have further led to new fields of research unimaginable to Einstein. For example, GPS data have been 'reprocessed' to conduct atmospheric research.[9] Jefferson Lab's CEBAF particle accelerator, the world's first superconducting accelerator, is used to conduct basic research of quarks and gluons under *relativistic* conditions. To enable this research, Jefferson Lab scientists and engineers were first tasked with inventing specialized CEBAF components.

Jefferson Lab's first patent was awarded four years before its first experiment,[10] and is part of the laboratory's cryogenic technology portfolio which is essential for superconducting accelerators. These patents have been licensed to Linde Cryogenics for installation at Jefferson Lab, Oak Ridge National Laboratory,[11] Brookhaven National Laboratory,[12] Michigan State University,[13] and at NASA's Johnson Space Center,[14] and will soon be installed at the Stanford Linear Accelerator Center.

Jefferson Lab inventors have been awarded over 150 US Patents. In addition to the cryogenic systems, the Laboratory has transferred patented technologies to other applications: CEBAF accelerator modules were components of the world's highest power

[8] T.S. Oluwadare1, R.R. Dawam, S.A. Achide, Oluwafemi A. Olawale, and Y.Y. Jabil, *Computation of Time Error in GPS Signals: Using Schwartzchild Time Dilation Equation*, INT. J. PURE APPL. SCI. TECHNOL., pp. 10-19, (2013).

[9] Ian D. Thomas, Matt A. King, Peter J. Clarke, and Nigel T. Penna, *Precipitable water vapor estimates from homogeneously reprocessed GPS data: An intertechnique comparison in Antarctica*, JOURNAL OF GEOPHYSICAL RESEARCH. ATMOSPHERES, v. 116, p. D04107, (2011).

[10] Ganapati R. Myneni, *Cryogenic Liquid Level Measuring Apparatus*, United States Patent 5,018,387, May 28, 1991.

[11] Ting Xu, Fabio Casagrande, Venkatarao Ganni, Peter Knudsen, and William Herb Strong, *Status of cryogenic system for spallation neutron source's superconducting radiofrequency test facility at Oak Ridge National Lab*, AIP Conference Proceedings 1434, 1085 (2012); available at https://aip.scitation.org/doi/pdf/10.1063/1.4707028.

[12] https://www.bnl.gov/newsroom/news.php?a=111305

[13] V. Ganni, P. Knudsen, D. Arenius, and F. Casagrande, *Application of JLab 12GeV helium refrigeration system for the FRIB accelerator at MSU*, AIP CONFERENCE PROCEEDINGS 1573, 323 (2014); available at https://aip.scitation.org/doi/pdf/10.1063/1.4860718.

[14] J. Homan, V. Ganni, A. Sidi-Yekhlef, J. Creel, R. Norton, R. Linza, G. Vargas, J. Lauterbach, J. Urbin, and D. Howe, *Floating Pressure Conversion of Two 3.5kW, 20 K, Helium Refrigerators*, AIP CONFERENCE PROCEEDINGS 1218, 1072 (2010); available at https://aip.scitation.org/doi/pdf/10.1063/1.3422268.

free electron laser (FEL)[15] and detector technologies used to study atomic nuclei are incorporated into life-saving breast cancer imaging instruments commercialized by a firm[16] located in the technology incubator adjacent to the laboratory. Patented nanomaterials licensed to another local company,[17] are direct products of research using Jefferson Lab's FEL. The laboratory's inventors received national recognition for these efforts, including a 2005 R&D 100 Award for the FEL and a 2009 Federal Laboratory Consortium for Technology Transfer Award for the breast cancer imaging technology. Jefferson Lab inventors are recognized by Laboratory management for their invention disclosures, provided monetary awards upon the grant of a patent, and share in licensing royalties as permitted under federal law.[18]

Equally important as its patents, Jefferson Lab actively contributes to academic technology transfer, as a 'user facility' where over 600 of the laboratory's doctoral 'alumni' conducted their dissertation research, and in the dissemination of information through over 1,900 peer reviewed publications.

Valuation, Time, and Risk

The complication of time and risk in the valuation of federal research investments is illustrated by the theoretical analyses and experimental facilities funded by NSF since the 1950s to detect the gravitational waves predicted by Einstein's research in *relativity*.[19] Until September 13, 2015, there were no 'observational returns' on that investment, although impacts from NSF's funding were significant, including at least 276 doctoral students who published dissertations between 1994 and 2014,[20] and the development of new equipment and analytical tools for these experimental facilities. Einstein's prediction of gravitational waves was experimentally verified the following day with the Nobel Prize winning observation of two black holes colliding.[21] A gravitational wave detected by the NSF-funded instruments and data from a similar instrument in Europe on August 17, 2017 was used to direct the observation of telescopes toward the collision of

[15] See, *Scientific Assessment of High-Power Free-Electron Laser Technology*, Committee on a Scientific Assessment of Free-Electron Laser Technology for Naval Applications Board on Physics and Astronomy Division on Engineering and Physical Sciences, the National Academies (2009).

[16] See Veronica Chufo, *Lab Spurs Breast-Imaging Advances*, DAILY PRESS; Newport News, Va. [Newport News, Va] 07 July 2009: A.5; available at http://articles.dailypress.com/2009-07-07/news/0907060050_1_gamma-camera-breast-cancer-cancer-detection.

[17] See Joe Lawlor, *Startup to Produce Nanotubes in NN: Material developed at Jefferson Lab to be manufactured for commercial use*, DAILY PRESS; Newport News, Va. [Newport News, Va] 04 Aug 2012: A.1.

[18] 15 USC § 3710a(b)(2)(5).

[19] J. Weber, *Detection and Generation of Gravitational Waves*, PHYS. REV., V 117, p. 306 (1960).

[20] Based on our search of the ProQuest Dissertations & Theses Global database on June 27, 2018.

[21] See, e.g., https://www.nsf.gov/news/news_summ.jsp?cntn_id=137628

neutron stars, resulting in the first cosmic event ever observed concurrently by both photonic and non-photonic means.[22]

The NSF's investment in gravitational wave research spans the tenure of every NSF Director. Few organizations, other than a Federal science agency such as NSF, would have the resolve or courage to provide sustained investment for more than five decades in a project that did not produce the project's primary intended result, even when risks are mitigated by incorporating sound science and engineering principles and approaches that were verified through rigorous peer review[23] and the Foundation's equally rigorous merit review process.

Valuation is further complicated when benefits from unanticipated or unforeseen uses, at least in an economic sense, are greater than what was originally intended: NSF's investments in honey bee modeling led to algorithms that determine the efficient routing of internet traffic;[24] DOD research investments of $500K on jet engine pressure sensors attracted $50 million in private equity funding establishing a medical device company commercializing monitors for brain aneurysms;[25] research on cyanoacrylate compounds was unsuccessful as a material for plastic gun sights, but subsequently found valuable uses as 'super glue'[26] and in the forensic imaging of fingerprints.[27]

Research at Corning Glass Works in 1952 on photosensitive glass inadvertently led to the discovery of 'glass-ceramics,' a class of materials that would become Corningware and used in missile nose cones.[28] Research on derivative materials led to 'Chemcor' a tough

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[22] See, e.g., https://www.nsf.gov/news/news_summ.jsp?cntn_id=243382; a second photonic/non-photonic observation was reported on July 12, 2018 when NSF's investments in the IceCube Neutrino Observatory detected an event that produced high energy cosmic neutrinos that was concurrently observed by ground-based and space-based telescopes. See https://www.nsf.gov/news/news_summ.jsp?cntn_id=295955

[23] *Gravitational Physics: Exploring the Structure of Space and Time*, Committee on Gravitational Physics, The National Academies, (1999). See e.g., recommendation to support technology development that will provide the foundation for future improvements in LIGO's sensitivity.

[24] See remarks of Rep. Ann M. Custer, CONGRESSIONAL RECORD, p. E1344, September 22, 2016; available at https://www.govinfo.gov/content/pkg/CREC-2016-09-22/pdf/CREC-2016-09-22-extensions.pdf; see also https://www.nsf.gov/impacts/impact_summ.jsp?cntn_id=243595&org=NSF&from=news.

[25] Prepared and as-delivered testimony of Mark G. Allen, Bayh-Dole Act (P.L. 96-517, Amendments to the Patent and Trademark Act of 1980) - The Next 25 Years: Hearing before the Subcommittee on Technology and Innovation, Committee on Science and Technology, House of Representatives, One Hundred Tenth Congress, First Session (July 17, 2007); available at https://www.govinfo.gov/content/pkg/CHRG-110hhrg36592/pdf/CHRG-110hhrg36592.pdf.

[26] Muhammad Moin, Irfan Qayyum, Anwar Ul-Haq Ahmad, Mumtaz Hussain, *Role of Temporary Tarsorrhaphy Using Super Glue in the Management of Corneal Disorders*, PAK J OPHTHALMOL 2009, Vol. 25 No. 3, p 139 at 141.

[27] Montgomery, Lauren; Spindler, Xanthe; Maynard, Philip; Lennard, Chris; Roux, Claude. *Pretreatment Strategies for the Improved Cyanoacrylate Development of Dry Latent Fingerprints on Nonporous Surfaces*, JOURNAL OF FORENSIC IDENTIFICATION; Alameda Vol. 62, Iss. 5, (Sep/Oct 2012): 517-542.

[28] George H. Beall, *Exploratory Research Remains Essential for Industry*, RESEARCH TECHNOLOGY MANAGEMENT; Nov/Dec 2002; p. 26 at 29; Bryan Gardiner, *Glass Works: How Corning Created the*

glass that was marketed beginning in 1962 but discontinued in 1971 due to poor sales. Research was resumed on this material in 2007 to leading to what is now 'Gorilla Glass,' used on hundreds of products worldwide, including all smart phones.[29]

Refocusing of Federal Technology Transfer Efforts

We believe it is inappropriate to "refocus Federal technology transfer on sound business principles based on private investment" if that would directly or indirectly encourage all investigator proposals or agency awards towards research that favors industrial 'relevance.' A National Institute of Standards and Technology report of a National Bureau of Standards (as NIST was previously known) research program portends possible federal research outcomes that could differ significantly from NSF's experience in gravitational wave research:

> One might have expected scientific studies with the topografiner to produce elegant experiments in surface physics at NBS for years to come but, surprisingly, that was not to be. In 1972 work on the instrument was stopped by Young's supervisors so that his ideas could advance the study of industrial surface finish in another part of the Bureau. The topografiner was perhaps the first major victim of the Bureau trend towards "relevance."
>
> Young's work with the topografiner was continued by Gerd Binnig and Heinrich Rohrer, employees of the IBM laboratories in Zurich, Switzerland. In 1986, they shared half of the Nobel Prize in physics for their design of the scanning tunneling microscope. The other half of the prize went to Ernst Ruska, who invented the electron microscope in 1931. The seminal work by Young, Ward, and Scire was noted in the Nobel documentation.[30]

The referenced research of Young, Ward, and Scire on the topografiner contributed to what another NIST report characterized as "an unusually creative and imaginative period of research . . ." at NBS. Nevertheless, there was an "abrupt termination of this project in 1971"[31] at the completion of the feasibility study for the topografiner, which was limited

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Ultrathin, Ultrastrong Material of the Future, wired.com, September 24, 2012, https://www.wired.com/2012/09/ff-corning-gorilla-glass/

[29] Id.

[30] James F. Schooley, *Responding to National Needs, The National Bureau of Standards Becomes the National Institute of Standards and Technology, 1969-1993*, NATL. INST. STAND. TECHNOL., SPEC. PUBL. 955, p. 424 (Nov. 2000); available at https://www.govinfo.gov/app/details/GOVPUB-C13-46d12668efb32c9efb34c9094a494747. An ironic coincidence to this story is the NBS Director that presided over the research of the topografiner and its termination subsequently served as the chief scientist of IBM during the research of the scanning tunneling microscope and the Nobel award.

[31] David R. Lide, Editor, *A Century of Excellence in Measurements, Standards, and Technology, A Chronicle of Selected NBS/NIST Publications 1901-2000*, NIST SPECIAL PUBLICATION 958, pp. 157-58,

in performance by mechanical vibrations because the appropriate vibration isolation equipment was beyond the project's "shoestring" budget.[32]

Binnig and Rohrer went to "enormous lengths to eliminate vibrations," and their first patent disclosure was submitted within the first year.[33] They characterized IBM's support: "During this development period, we created and were granted the necessary elbowroom to dream, to explore, and to make and correct mistakes. We did not require extra manpower or funding, and our side activities produced acceptable and publishable results."[34]

Just a few years later, IBM researchers would no longer enjoy the wholesale research support afforded to Binnig and Rohrer, as budget issues led to staff cuts and basic scientists who remained were "redirected into applied research."[35] Other industry stalwarts of basic research, like Bell Labs followed suit or, like Xerox's Palo Alto Research Center, initiated a research-for-hire model to support outside clients.[36]

We disagree with the premise of the RFI that the results of the federal investment in research "must be transferred to private companies to create new products and services," at least as a specific objective of all funded research. We do agree that there must be a transfer of technologies developed with federal funding, including the education of future researchers and the publication their doctoral dissertations, publications in peer reviewed journals, and presentations at scientific conferences. We refer to the above example of Einstein's work which only after decades led to the invention of the GPS and particle accelerator, which themselves led to further research in atmospheric science and the development of proton beam cancer therapies, respectively.

Industry's "businessification of research"[37] leaves the Federal Government as the sole sponsor of discovery research. Federal investments in research do have valuable technology transfer opportunities, particularly when those efforts involve major research

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January 2001); available at https://www.govinfo.gov/app/details/GOVPUB-C13-310bc7b3121ed82b8f13fc15a5c9e639.

[32] Cyrus Cawas Maneck Mody, *Crafting the tools of Knowledge: The Invention, Spread, and Commercialization of Probe Microscopy, 1960-2000*, DOCTORAL DISSERTATION, CORNELL UNIVERSITY, pp. 66-67, August 2004; available at: https://app.box.com/s/oi4p4eknm9kytnrza3a5733d1x0zlhf9.

[33] THE ECONOMIST, *Learning to See Atoms*, pp. 80-81, January 30, 1999; Gerd Binnig and Heinrich Rohrer, *Scanning tunneling microscopy – from birth to adolescence*, REV. MOD. PHYS., p. 615, (l July 1987).

[34] Gerd Binnig and Heinrich Rohrer, *Scanning Tunneling Microscopy – from Birth to Adolescence*, REVIEWS OF MODERN PHYSICS, p. 615, July 1987.

[35] David H. Freedman, *A Clouded Future for IBM Research, Science*, SCIENCE, p. 480, 23 April 1993. See also, William Sweet, *IBM Cuts Research in Physical Sciences at Yorktown Heights and Almaden*, PHYSICS TODAY, p. 75 (1993).

[36] Dennis K. Berman, *Hard Times Hurt Pure Science at Bell Labs – Under Weakened Parent Lucent, Famed Sanctuary for Theorists Goes in a More Practical Direction*, WALL STREET JOURNAL , EUROPE; p. A5, 26 May 2003.

[37] Robert F. Service, *Relaunching Bell Labs*, SCIENCE, p. 638, 3 May 1996.

facilities that require the invention of highly specialized instrumentation and equipment. While ‘off label’ applications of research should never distract from a program’s primary objectives, our experience is there can be synergies. Jefferson Lab’s FEL used CEBAF accelerator modules which provided additional data and operational experience with those modules. Off label opportunities exist at other Federal laboratories, such as the NSF’s National Radio Astronomy Observatory, where its radio telescopes contribute to earth science studies[38] and support the US Navy’s precision timekeeping mission.[39] NSF’s National Center for Atmospheric Research transfers technology to outside entities, including Federal ‘mission’ agencies such as the National Oceanic and Atmospheric Administration and the Federal Aviation Administration and to non-federal organizations.[40]

Congress recognized these off label opportunities in Section 102(c)[41] of the American Innovation and Competitiveness Act[42] where it instructed the National Science Foundation to apply seven ‘broader impacts’ criterion to the review of research proposals. Four criterion relate to directly technology transfer of federal research investments,[43] which include the Foundation’s 21 major research facilities in the US, four of which are Federally Funded Research and Development Centers (FFRDCs).

FFRDCs may offer particular technology transfer opportunities because the federal regulations that authorize their establishment require that they meet “some special long-term research or development need which cannot be met as effectively by existing in-house or contractor resources.”[44] For laboratory FFRDCs, these resources likely include specialized equipment that is unavailable elsewhere, requiring their design or invention. While not a regulatory requirement, a similar need probably exists at other specialized research facilities, particularly those which are government owned.

We have no mechanism to determine the impact or attention of federal investments by NSF and other agencies to these technology transfer criterion, but imagine there could be

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[38] Sarah Böckmann, T. Artz, A. Nothnagel, *VLBI terrestrial reference frame contributions to ITRF2008*, J GEOD., p. 201, (2010); Volker Tesmer, Peter Steigenberger, Markus Rothacher, Johannes Boehm, Barbara Meisel, *Annual deformation signals from homogeneously reprocessed VLBI and GPS height time series*, J GEOD. p. 973 (2009).

[39] Ethan J. Schreier, Written Testimony before U.S. House of Representatives Committee on Science, Space, and Technology Subcommittee on Research and Science Education, April 18, 2012; available at: https://www.govinfo.gov/content/pkg/CHRG-112hhrg74056/pdf/CHRG-112hhrg74056.pdf.

[40] National Science Foundation, FY 2018 Budget Request to Congress, May 23, 2017, page Facilities - 56; available at: https://www.nsf.gov/about/budget/fy2018/pdf/fy2018budget.pdf

[41] Codified at 42 USC § 1862p-14(a).

[42] P.L. 114-329.

[43] (1) Increasing the economic competitiveness of the United States; (2) Advancing of the health and welfare of the American public; (3) Supporting the national defense of the United States; (4) Enhancing partnerships between academia and industry in the United States.

[44] 48 CFR § 35.017(a)(2).

unidentified or underutilized opportunities for synergistic deployments to off label applications.

While most Federal agencies require that inventions developed under federal funding be disclosed to the NIH-managed 'iEdison' database, it is not clear how that data is used, or the extent to which the sponsoring agency, or other agencies, might use that information to facilitate technology transfer.[45] In any event, the iEdison data is not publically available, like the iBridge Network,[46] an online marketplace for technologies developed by academic researchers, including those at Jefferson Lab.

We believe the Department of Energy is particularly effective in facilitating the transfer of technologies from its 17 National Laboratories, 16 of which are FFRDCs, which undoubtedly explains in part how the scientists at its smallest FFRDC National Laboratory can be the inventors of what may be the most lucrative patent developed at a Federal laboratory.[47] This is due to DOE's long standing and active participation in the transfer of technologies from the entities that it funds, an effort that recently added a laboratory partnering service to facilitate industry interactions.[48] Few, if any, of the other Federal agencies are engaged at this level. Some of the Federal agencies offer no particular participation or encouragement in the transfer of technologies specific to their FFRDC laboratories or major research facilities which, like Jefferson Lab, require the invention of sophisticated equipment and instrumentation to enable the specialized experiments or scientific observations performed at those laboratories or research facilities.

Part II.

Government patent practices and policies at federally-owned laboratories has been the subject of extensive study within, and outside, the government, over many decades. The first such effort was commissioned by President F. Roosevelt at a time when at least some Federal agency patent policies were based in the common law.[49] Those studies have informed development of the Bayh-Dole[50] and Stevenson-Wydler[51] Acts in 1980 and their subsequent amendments. For example, the implementation of the Stevenson-

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[45]Prepared and as-delivered testimony and responses to written questions from Elizabeth Hoffman and from Robert Weissman before United States Senate Judiciary Committee hearing regarding The Role of Federally-Funded University Research in the Patent System October 24, 2007; available at: https://www.govinfo.gov/content/pkg/CHRG-110shrg43657/pdf/CHRG-110shrg43657.pdf.

[46] ibridgenetwork.org

[47] https://www.energy.gov/articles/after-15-years-new-top-earning-patent-ames-lab

[48] https://www.energy.gov/technologytransitions/articles/doe-launches-new-lab-partnering-service

[49] U.S. Department of Justice, *Report and Recommendations of the Attorney General to the President,* p. 23 (1947); available at: https://app.box.com/s/ds6gvpw5x1odpx60egptyt7mmu7uror5.

[50] Bayh Dole Act (Chapter 38. P.L. 96-517, Patent Rights in Inventions Made with Federal Assistance).

[51] Stevenson-Wydler Technology Innovation Act of 1980 (P.L. 96-480).

Wydler Act to stimulate "utilization of federally funded technology developments,"[52] has been the subject of 22 Congressional hearings from August 1981 through May 2000.[53]

Cooperative Research and Development Agreements (CRADAs)

Stevenson-Wydler was amended in 1986 through the Federal Technology Transfer Act of 1986[54] establishing Cooperative Research and Development Agreements (CRADAs) and authorizing Government Operated laboratories at "each Federal agency" to enter into such agreements "with other Federal agencies; units of State or local government; industrial organizations (including corporations, partnerships, and limited partnerships, and industrial development organizations); public and private foundations; nonprofit organizations (including universities); or other persons (including licensees of inventions owned by the Federal agency)."[55] The CRADA statute also provides "each Federal Agency" the authority to negotiate patent license agreements for its laboratory inventions.

As a result of the extensive public discourse in Congress and elsewhere[56] the CRADA statute has been amended seven times from 1988-2000. Those amendments improved the statute by expanding CRADA authority beyond patents to include "other intellectual property";[57] extending CRADA authority to Government-owned, contractor-operated laboratories;[58] explicitly offer the provision of "intellectual property" under a CRADA;[59] explicitly granted CRADA authority to NNSA sites, including "production facilities"[60]; guaranteeing CRADA partners an opportunity to elect an exclusive license for foreground patents in a specified field of use;[61] providing FOIA protection of "trade secrets and commercial or financial information" under Exemption 4;[62] and reducing statutory agency approval time from 90 to 30 days.[63]

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[52] P.L. 96-480, Section 3.

[53] Based on our search of the HeinOnline database on June 19, 2018.

[54] P.L. 99-502.

[55] P.L. 99-502 Section 2.

[56] See e.g., Committee on a National Strategy for Biotechnology in Agriculture, National Research Council, *Agricultural Biotechnology: Strategies for National Competitiveness* (1987); Board on Science, Panel on the Government Role in Civilian Technology, National Academy of Sciences, National Academy of Engineering, Institute of Medicine, *The Government Role in Civilian Technology: Building a New Alliance* (1992).

[57] P.L. 100-418.

[58] P.L. 101-189.

[59] P.L. 102-484.

[60] P.L. 103-160.

[61] P.L. 104-113.

[62] P.L. 104-113.

[63] P.L. 106-389.

Other Statutory Authorities

A CRADA is not the only collaborative research instrument authorized in statute. Section 33[64] of the Atomic Energy Act of 1954[65] allows the Department of Energy to conduct 'Research for Others.' More commonly known as a 'Work for Others' or 'Strategic Partnership Project,' Section 33 has been the subject of five congressional hearings from 1954 to 1973, [66] and was amended in 1967 to authorize the Department to "assist other persons . . . [in conducting] research and development or training activities and studies," and again in 1971 to expand this assistance to the development of energy beyond nuclear energy.

Unlike that for CRADAs, the Research for Others statute provides few details about what is, and is not, the Congressional intent in its authorization of collaborative research. For example, discussion at a 1960 Congressional hearing seemed to indicate some confusion over statutory intellectual property rights under this authority.[67]

Jefferson Lab does have Section 33 authority to engage in 'Research for Others,' but finds CRADAs preferable for collaborative research engagements because of the intellectual property protections afforded the non-federal collaborator, the laboratory's management and operating contractor, and laboratory employees. We do utilize Section 33 agreements in instances where there are no expectations of jointly-developed foreground intellectual property, such as testing services for outside entities and as a mechanism to access laboratory facilities. Laboratory access and testing services are, *per se*, a form of technology transfer from the laboratory, albeit at a much lower level and much lower frequency than CRADAs at Jefferson Lab.

Under the Federal Nonnuclear Energy and Research and Development Act of 1974,[68] title to inventions funded under a contract from the Department of Energy vests to the United States, unless the Secretary of Energy waives such vesting.[69] However, the effect of this automatic vesting to the government has been lessened in certain circumstances by Department of Energy regulations.[70]

Other agencies conduct research under their statutory 'Other Transactions Authority.' For example, the National Aeronautics and Space Act of 1958[71] authorizes the National

[64] Codified at 42 USC § 2053.

[65] P.L. 83-703.

[66] Based on our search of the HeinOnline database on June 25, 2018.

[67] Omnibus Bills, 1960, Hearings before the Subcommittee on Legislation of the Joint Committee on Atomic Energy, United States Congress, 86th Congress, May 17 and 18, pp 24-25 (1960); available at: https://app.box.com/s/bdqb7hv49g1oerned46wwmcffac6errs.

[68] P.L. 93-577 Section 9.

[69] 42 USC § 5908(a).

[70] 48 CFR §§ 970.2703-1, 970.2703-2, 970.5227-3, 970.5227-12.

[71] P.L. 85-586 Section 202(b)(5).

Aeronautics and Space Administration to "to enter into and perform such contracts, leases, cooperative agreements, or other transactions as may be necessary in the conduct of its work and on such terms as it may deem appropriate,"[72] where 'other transactions' are not defined in statute. "Because an 'other transaction' is not a procurement contract, cooperative agreement, or grant, it is not subject to the laws, regulations, and other requirements governing such traditional contracting mechanisms."[73]

The Space Act's Other Transactions Authority has not been substantively amended in the nearly six decades since its enactment and has received only limited review, at least in Congressional hearings.[74]

Analysis

We believe CRADAs strike an appropriate balance between public and private interests for collaborative research activities at Federal laboratories. It provides a guarantee to limited intellectual property rights to the collaborating party to incentivize joint research projects at a Federal laboratory while allowing the Federal Government access to that intellectual property for its purposes and encouraging economic development in the United States. The statute explicitly states a preference for inventions to "be manufactured substantially in the United States,"[75] but agencies, such as the Department of Energy, with experience issuing CRADAs may accept an "alternative benefit" to products actually manufactured in the United States.[76]

While statutory CRADA authority is available to "each Federal agency," practice across Federal laboratories does not seem to satisfy the "desirability of uniformity," at least with regard to the Federal agency patent policies that were recommended by the Justice Department more than 70 years ago.[77] For example, the National Science Foundation sponsors four Government-Owned Contractor-Operated FFRDC laboratories and several other 'large facilities,'[78] where CRADAs are rarely, if ever, used for research collaborations involving these facilities. Our understanding is that most, if not all,

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[72] 51 USC §20133(e).

[73] David S. Bloch; James G. McEwen, *Other Transactions with Uncle Sam: A Solution to the High-Tech Government Contracting Crisis*, 10 TEX. INTELL. PROP. L.J. 195 at 210, (2002).

[74] See e.g., Government procurement and contracting. Hearings before a subcommittee of the Committee on Government Operations, House of Representatives, Ninety-first Congress, first session, on H.R. 474, to establish a Commission on Government Procurement, pp 514-522 (1969); available at: https://app.box.com/s/mrxqm72yuywjoc08nne3a2xk9jw9jxuj.

[75] 15 USC § 3710a(c)(4)(B).

[76] See DOE Cooperative Research and Developments Manual, DOE M483.1-1, Article XXII: U.S. Competitiveness; available at https://www.energy.gov/sites/prod/files/gcprod/documents/m4831-1.pdf.

[77] U.S. Department of Justice, *Investigation of Government Patent Practices and Policies - Report and Recommendations of the Attorney General to the President* (1947); available at: https://app.box.com/s/ds6gvpw5x1odpx60egptyt7mmu7uror5.

[78] https://www.nsf.gov/bfa/lfo/docs/large-facilities-list.pdf

collaborative research engagements at NASA centers are through Space Act Agreements and not CRADAs.

We and our co-workers work with, or at, four NASA centers and the anecdotal reports that we receive are that negotiation of Space Act agreements, at least for research projects, is an extremely time-consuming process. The absence of defined intellectual property rights for collaborating parties undoubtedly complicates the negotiation process. In recent research collaborations, our Jefferson Lab colleagues declined a NASA center's offer to use a Space Act Agreement because of these intellectual property issues, choosing instead to enter in an interagency agreement that we believed offered more fair intellectual property rights to the Department of Energy, Jefferson Lab's management and operating contractor, Jefferson Lab's inventor-researchers, and ultimately private industry.

Agencies have issued policies and regulations to provide better clarity to Section 33 and Other Transactions research activities. Those statutory authorities, policies, and regulations do not have the government-wide uniformity or intellectual property provisions of a CRADA that we believe would facilitate private sector utilization of federal research facilities.

Part III.

1. ***What are the core Federal technology transfer principles and practices that should be protected, and those which should be adapted or changed?***

We believe uniformity in accessing Federal laboratories across all agencies will help to facilitate Federal technology transfer and that for research and development collaborations, CRADAs generally offer an appropriate balance that protects the interests of non-federal collaborators, the Federal Government, and the management and operating contractors in the case of government-owned contractor-operated facilities. As we noted in Part II, the need for uniform technology transfer policies across Federal agencies was identified by the Department of Justice as far back as 1947. It is our observation that some of the science agencies who 'own' government-operated or contractor-operated laboratories exclusively choose to conduct technology transfer under statutory authority unique to those agencies or in some instances, under no particular statutory authority, and we believe this leads to inefficiencies when a non-federal entity desires to engage in collaborative research with several agencies' laboratories. Moreover, we believe a CRADA's statutory intellectual property rights are fair for the Federal and non-federal entities and for the contractor in the case of a contractor-operated Federal laboratory. The absence of statutory intellectual property rights in other mechanisms of collaboration can complicate or prolong the negotiation of a research agreement as we previously described.

2. ***What are the issues that pose systemic challenges to the effective transfer of technology, knowledge, and capabilities resulting from Federal R&D? Please consider those identified in the RFI as well as others that may have inhibited collaborations with Federal laboratories, access to other federally funded R&D, or commercialization of technologies resulting from Federal R&D.***

3. ***What is the proposed solution for each issue that poses a systemic challenge to the effective transfer of technology, knowledge, and capabilities resulting from Federal R&D? Please consider the approaches identified in the RFI.***

March-In and US Preference requirements: Government March-In rights and US preference provisions are often cited as impediments to non-federal collaboration with a Federal laboratory. We do not believe these are issues, particularly as in the case of the Department of Energy where 'alternate benefits' may be accepted in appropriate circumstances in lieu of contractual commitments to manufacture subject inventions in the United States.

Advance Payment Requirements: Under the Antideficiency Act[79] a Federal laboratory cannot "make or authorize an expenditure or obligation exceeding an amount available in an appropriation or fund for the expenditure or obligation." The practical effect is that engagement of a Federal laboratory, including one that is contractor-operated, generally requires advance payment of 60-90 days of anticipated costs – a practice that is uncommon in the private sector.

The Department of Energy has addressed this issue at its FFRDC laboratories with regard to the non-federal collaborator through 'Agreements for Commercializing Technology'[80] (ACT) established under DOE's Atomic Energy Act's Section 33 'Research for Others'[81] authority. Under an ACT, Antideficiency Act obligations are satisfied because the management and operating contractor for the FFRDC laboratory makes the advance payment instead of the non-federal collaborator in exchange for an opportunity to charge higher fees to the non-federal collaborator. This arrangement shifts all of the risk to the laboratory's management and operating contractor, which may be unacceptable or inappropriate, particularly for nonprofit or university contractors. Moreover, this statutory authority applies only to the Department of Energy and therefore is not an approach that can be applied across Federal agencies.

We understand there is little chance to amend the Antideficiency Act for technology transfer purposes, but the establishment of a repayable loan or grant program that could relieve the burden from non-federal collaborators and nonprofit or university contractors

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[79] 31 USC § 1341(a)(1).

[80] https://www.energy.gov/sites/prod/files/2018/04/f50/%238%20v13%20ACT%20AL%20Hclause%20to%20HCAs-FINAL-CLEAN-REV5-Berta%203-30%20w-CFO-TTO%20edits_1.pdf

[81] P.L. 83-703

might help to bring the funding aspects of Federal laboratory engagements more in line with private sector practices.

4. ***What are other ways to significantly improve the transfer of technology, knowledge, and capabilities resulting from Federal R&D to benefit U.S. innovation and the economy? What changes would these proposed improvements require to Federal technology transfer practices, policies, regulations, and legislation?***

We believe the transfer of technologies developed with federal funding could be facilitated by increasing an awareness of available technologies. In order to be more effective than merely a search of the USPTO database, such outreach efforts should include curation that describes the technologies in a context, perhaps in conjunction with other available technologies and in the case of Federal laboratories, clearly indicating that established collaboration mechanisms are available to further develop the technologies.

iEdison

The iEdison database might provide some of the data for such an effort but would require the curation described above to be of value. The nonprofit iBridge Network does have a searchable taxonomy to facilitate this curation and provides academic researchers opportunities to add additional information. The iBridge database could be useful when this additional information is added, but many of the current entries are of limited value, including the wholesale download NSF Fastlane data, because they are only a list of titles and abstracts of funded projects. We believe diluting a curated database with low quality data diminishes the value of the entire database.

Something resembling NSF's requirement for a "Project Outcomes Report for the General Public" that articulates potential technology transfer opportunities might be one way to facilitate this awareness.[82] NSF also requires its funding recipients report on the commercialization of research results,[83] but this only applies to universities. In addition to universities, NSF supports four FFRDC laboratories which are not subject to this requirement. We believe research facilities generally, and FFRDCs specifically, have particular opportunities to transfer technologies related to the specialized instrumentation that they have developed.

Department of Energy

Some of the Department of Energy's technology transfer efforts may serve as examples for similar initiatives at other agencies. For a number of years, DOE has been hosting agency-wide programs to facilitate technology transfer from its laboratories, including the Technology Transfer Working Group[84] which meets in person and online several times each year, and an annual conference of the Patent Counsels from DOE headquarters, its field offices, and its National Laboratories. These interactions provide

[82] 42 USC § 1862o-2

[83] 42 USC § 1862p-10(a)(3)

[84] https://www.energy.gov/technologytransitions/technology-transfer-working-group-ttwg

opportunities for the technology transfer staffs from different laboratories to exchange 'best practices' and 'lessons learned' and could facilitate collaborative technology transfer efforts on similar or complementary technologies. One technology transfer colleague from a non-DOE laboratory expressed a regret that similar forums were not available across that agency's laboratories.

DOE will soon start hosting 'Innovation X Lab' conferences, each focusing on specific topics to connect experts from the national laboratories with relevant expertise in the conference topic with interested industry representatives.[85] Another new addition is DOE's 'Lab Partnering Service' facilitating introductions between investors and others interested in new technology developments with experts across the DOE national laboratory complex.[86] All of these activities are coordinated through the Department's Office of Technology Transitions, an organization that has no counterpart in some of the other Federal science agencies.

[85] http://www.doeinnovationxlab.com/

[86] https://www.labpartnering.org/; https://www.energy.gov/articles/doe-launches-new-lab-partnering-service