THE NATIONAL ACADEMIES
Advisers to the Nation on Science, Engineering, and Medicine

February 5, 2004

Dr. Hugh Van Horn
Program Director
Division of Materials Research
National Science Foundation
4201 Wilson Boulevard
Arlington, Virginia 22230

Dear Dr. Van Horn:

I write as chair of the National Research Council's Committee on Opportunities in High Magnetic Field Science (COHMAG) to report on the progress of the committee's deliberations to date. COHMAG has met twice: once in Washington, D.C., in September 2003 and again in Tallahassee, Florida, in December 2003. (Membership of the committee and agendas for these meetings are appended to this letter.) A final meeting is anticipated this coming spring, and the committee's report should be completed a few months after that.

The charge to which COHMAG's full report will respond has four components: (1) to assess the current state and future prospects of high magnetic field science and technology in the United States, (2) to assess the position of the United States in this area in the international context, (3) to identify promising multidisciplinary areas for research and development, and (4) to review and prioritize major magnet construction initiatives for the next decade. Although it has not yet completed the discussions that will result in the development of its final conclusions and recommendations, the committee does have a sense of the current status of the area of high magnetic field science, and it has identified most of the major issues.

It is important to understand from the outset how difficult it is to build magnets significantly more powerful than those operating today. Since the National High Magnetic Field Laboratory was established in Tallahassee about a decade ago, the field strengths of the most powerful direct current magnets available have increased by about 50 percent, but only at great expense and with great effort. There are a host of technical challenges. The stresses in high-field magnets test the strengths of the materials of which they are built. If the magnet is resistive, management of the heat it generates is a major problem, as are the ongoing cost of the power it consumes and the capital cost of the power supply needed to energize it. If the magnet is superconducting, the sensitivity of the resistance of the superconductor it contains to temperature and magnetic field strength limits performance, and management of the energy stored in the magnet's field is crucial because accidental quenching is an ever-present possibility. In short, high-field magnet development is a very challenging area at the intersection of science and engineering, and in the future, increases in field strength as small as 10 percent will be hard won. Measured by the potential for constructing magnets that deliver even higher fields, the opportunities available in this area of science and technology are modest, but as the committee will endeavor to make clear in its final report, they are worth fighting for, especially because improvements in superconducting magnet technology could make high-field magnets more

BOARD ON PHYSICS AND ASTRONOMY • Tel 202-334-3520 • Fax 202-334-3575 • E-mail bpa@nas.edu
NATIONAL ACADEMY OF SCIENCES • NATIONAL ACADEMY OF ENGINEERING • INSTITUTE OF MEDICINE • NATIONAL RESEARCH COUNCIL

available for use.

The committee invited speakers to its first two meetings to brief its members on relevant fields of science and technology, including magnet technology and instrumentation, nuclear magnetic resonance in all its manifestations, semiconductors and heterostructures, high-temperature superconductors, ion cyclotron resonance, low-dimensional electron systems, magnetic resonance imaging, and the use of magnets in high energy physics and fusion science. The U.S. position is strong in most areas of science that depend on access to high magnetic fields but is not necessarily world-leading across the board. The committee is investigating further to flesh out the details, but it is convinced that it is important that the United States maintain facilities where cutting-edge research in magnet technology is carried out, and that the products of this research be made available to the wider community of scientists and engineers: There is a great deal of important, exciting science that can be done only at facilities of this kind. In addition, advances both in magnet design and in our fundamental understanding of magnetism are certain to have beneficial impacts on a host of technologies critical to the national welfare as well as on the many areas of science that use magnet-based technologies. The committee is still formulating its recommendations about how best to invest national resources in this area.

Many additional questions are currently under discussion in the committee. For example, what can be done to make high-field magnets more available for use at national neutron sources and synchrotron light sources? What can be done to expand the access of scientists and engineers to high magnetic fields for research purposes more generally, and to increase the size of that user community? What research in magnet technology would do the most to advance the many fields of science that use magnetic fields? How should publicly sponsored research in magnet development be organized, given the existence of large efforts in the private sector that are driven by the market for MRI instruments and NMR spectrometers, both of which use superconducting magnets?

I trust this letter is sufficient to give you a sense of where COHMAG's deliberations are taking it, and I look forward to transmitting a full report to you in the second half of 2004.

Sincerely yours,

/s/ Peter Moore, *Chair*
Committee on Opportunities in High Magnetic Field Science

Appendix A
Committee Membership

Peter B. Moore, ***Chair***
Professor of Chemistry
Yale University

Gabriel Aeppli
Professor of Physics and Astronomy
University College London

Meigan Aronson
Professor of Physics
University of Michigan

Paul M. Chaikin
Professor
University of Princeton

Paul D. Ellis
Technical Group Leader
Pacific Northwest National Laboratory

Peter F. Green
Professor of Chemical Engineering
University of Texas at Austin

David C. Larbalestier
Professor of Materials Science and Engineering and Director, Applied Superconductivity Center
University of Wisconsin at Madison

J. David Litster
Vice President for Research and Dean for Graduate Education
Massachusetts Institute of Technology

Joseph Minervini
Senior Research Engineer and Head, Fusion Technology and Engineering Group
Plasma Science and Fusion Center
Massachusetts Institute of Technology

J. Michael Rowe
Director
National Institute of Standards and Technology Center for Neutron Research

John M. Rowell
Professor of Materials Research
Arizona State University

Mansour Shayegan
Professor of Electrical Engineering
Princeton University

Robert Tycko
Chief of Solid State NMR and Biomolecular Physics Section
National Institute of Diabetes and Digestive and Kidney Diseases
National Institutes of Health

Valerii Vinokur
Senior Scientist
Materials Science Division
Argonne National Laboratory

Appendix B
Meeting Agendas

FIRST MEETING
KECK CENTER OF THE NATIONAL ACADEMIES
WASHINGTON, D.C.

Thursday, September 4, 2003

Closed Session

8:30 am Welcome
8:45 am Introduction to the National Academies and the study process
—Maureen Mellody, Program Officer
9:00 am Goals and opening thoughts
—Peter Moore, Chair
10:30 am Composition and balance discussion
—Don Shapero, Director
11:30 am Discussion of the task and scope of the study

Open Session

1:00 pm Perspectives from the Division of Materials Research at NSF
—Hugh van Horn, Program Director, National Science Foundation
1:30 pm Perspectives from the Office of Basic Energy Sciences at DOE
—William Oosterhuis, Program Manager, Department of Energy
2:00 pm Perspectives from the Office of Fusion Energy Sciences at DOE
—Joseph Minervini, Massachusetts Institute of Technology
2:30 pm Perspectives from the National Institute of Standards and Technology
—J. Michael Rowe, Director, NIST Center for Neutron Research
3:00 pm Break
3:15 pm Outcomes of the 1988 Large Magnetic Fields report for NSF
—Frederick Seitz, Rockefeller University
4:30 pm Perspectives from the commercial sector
—Michael Cuthbert, Oxford Instruments
5:30 pm Adjourn for the day

Friday, September 5, 2003

Open Session

8:30 am Biology and nuclear magnetic resonance
—Rob Tycko, National Institutes of Health
9:00 am Semiconductors and heterostructures
—Mansour Shayegan, Princeton University

9:30 am Technology and instrumentation
—Greg Boebinger, NHMFL
10:30 am Break
11:00 am High temperature superconductors
—David Larbalestier, University of Wisconsin at Madison
11:30 am Magnetic materials
—Meigan Aronson, University of Michigan
12:00 pm International perspectives
—Gabriel Aeppli, University College London
12:30 pm Lunch

Closed Session

1:30 pm Committee discussions
3:00 pm Adjourn

SECOND MEETING
NATIONAL HIGH MAGNETIC FIELD LABORATORY
TALLAHASSEE, FLORIDA

Monday, December 8, 2003

Open Session

8:30 am Welcome and goals for the meeting
—Peter Moore, Cahir
9:00 am NHMFL facilities and plans
—Greg Boebinger, NHMFL
10:00 am Ion cyclotron resonance
—Alan Marshall, Florida State University
10:30 am Break
11:00 am Magnets and high energy physics
—Steve Gourlay, Lawrence Berkeley National Laboratory
12:00 pm Lunch
1:00 pm Magnetic resonance imaging
—Tom Mareci, University of Florida
2:00 pm Commercial magnet technology
—Razvan Teodorescu, Bruker Biospin Corporation
3:00 pm Break

Closed Session

3:30 pm Committee discussions
5:30 pm Adjourn for the day

Tuesday, December 9, 2003

Open Session

8:30 am	Tour of the NHMFL facilities
10:30 am	Break
11:00 am	Low-dimensional electron systems Horst Stormer, Columbia University
12:00 pm	Lunch

Closed Session

1:00 pm	Committee discussions
5:00 pm	Adjourn