First and foremost, Hall's techniques are used in virtually all diamond abrasive synthesis. More than 100 tons of diamond abrasives (more than have been mined in human history) are now produced *every year*. This multi-billion dollar industry provides cheap and reliable abrasives that affect our lives in many ways. Eye glasses once took weeks to order, but now are available in an hour. Road repairs once required destructive and noisy jackhammers, but now roads can be repaired with surgical precision using diamond saws. Reinforced concrete structures, including dams and power plants, can now be modified with ease. Diamond machine tools are vital to national security, in the machining of high-tech carbide components. They also find myriad uses in faster and cheaper manufacturing of automobiles, appliances, aircraft, and other products. Synthetic diamonds enhance our lives in many other subtle ways. A wonderful variety of polished ornamental stones, including hard and durable rocks such as granite, are now cheap and commonplace. And synthetic diamonds also make dental work faster and safer. Countless jobs and billions of dollars of American productivity are a direct result of Tracy Hall's discoveries.

Finally, I must insert a personal note. Hall's advances have played a major role in high-pressure science. His designs for high-pressure devices are still widely used and have led to many fundamental discoveries about the nature of the earth's deep interior. The belt idea, furthermore, has been incorporated into the widely-used diamond anvil cell, which has pushed the frontiers of high-pressure research to millions of atmospheres. All high-pressure scientists are in Tracy Hall's debt.

At the time of Hall's breakthrough in 1954, diamond synthesis was a Holy Grail of chemistry. Several famous scientists, including Nobel laureates Percy Bridgman and Frederick-Henri Moissan, had tried and failed. Had GE nominated Tracy Hall for the Nobel Prize, many of his peers believe that he stood a very strong chance of winning. GE, however, pushed the teamwork concept and claimed that four men should share equal credit. (Nobel Prizes can go to no more than three.) While Bundy, Strong, and Wentorf played key roles in the GE effort, there can be no doubt that Tracy Hall's contribution was most central to the group's success.

The Draper Prize would be a fitting tribute to Tracy Hall.

Sincerely,

Robert M. Hazen

RMH/tex

January 30, 1997

Mr. Charles E. Blue
Charles Stark Draper Prize
National Academy of Engineering
2101 Constitution Avenue, N.W., NAS069
Washington, D.C. 20418

Dear Mr. Blue:

This letter is to support Mr. H. Tracy Hall's nomination for the Charles Stark Draper Prize.

My name is Doug Rock and I am Chairman and Chief Executive Officer of Smith International, Inc. Our company is in the oil and gas service business. We have 6,000 employees, annual revenues in excess of one billion dollars, and our stock has traded on the New York Stock Exchange for the past thirty years.

I first came to know Mr. Hall in the early 1980s when Smith International purchased Megadiamond, a company that Mr. Hall co-founded in Provo, Utah in the early 1960s. Mr. Hall is the inventor of the synthetic diamond process. He further refined that process over two decades while at Megadiamond. In 1972 Mr. Hall was awarded The American Chemical Society gold medal for creative invention. In part, the citation read:

> *"...for being the first to discover a reproducible reaction system for making synthetic diamonds from graphite, and for the concept and design of a super high pressure apparatus which not only made the synthesis possible, but brought about a whole new era of high pressure research..."*

Although Mr. Hall's inventions can be praised for their technological eloquence, his real contribution lies in the significant social contribution of his ideas. Mr. Hall's invention of the synthetic diamond process has had a great impact on simplifying and enriching people's lives throughout the world.

At Smith International, we use synthetic diamonds of Mr. Hall's invention to significantly reduce the cost of drilling oil wells. Synthetic diamond drill bits which were made possible by Mr. Hall's invention save billions of dollars per year in the cost of energy exploration. These savings are passed on to consumers in the form of lower gas

prices, heating bills for the home and lower cost for all products using petrochemicals such as plastics, personal care items and medicines.

Other technologies outside our industry that have emanated from Mr. Hall's invention include:

- Synthetic diamond grit used extensively in grinding wheels and masonry saws. Industrial diamond grit is manufactured by every major nation and the output can be measured in tons.

- Diamond insert cutting tools that provide new frontiers of design freedom to machine sophisticated alloys and composites that cannot be machined by other techniques.

Smith International uses the cubic presses that were invented by Mr. Hall to make, in addition to diamond, other super hard materials such as cubic boron nitride for use in wear parts and inserts for machining ferrous materials. Mr. Hall invented the process for producing synthetic diamonds while working for General Electric. When Mr. Hall left G.E., he was not able to use in his work the high pressure belt apparatus he had just invented. However, because of his inventive ability, within two years he had perfected a new device, the tetrahedral or cubic press. To this day, his apparatuses are the only methods used in manufacturing synthetic diamond.

Mr. Hall's synthetic diamond technology has been adopted throughout the world. It is manufactured and incorporated into products in all major industrialized nations including China and Russia. Today, new materials and technologies are continually being developed based on the foundation of Mr. Hall's invention and core technologies, opening up an infinite number of future opportunities to further enhance the quality of our lives.

In my view, the invention of synthetic diamonds is one of the chemical and materials breakthrough events of this century. Besides being a world class scientist, I also know Mr. Hall to be a loving husband, a caring father, a devout religious leader, and an active member in his community.

Sincerely,

Doug Rock

/jm

AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Executive Office

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February 7, 1997

Mr. Charles E. Blue
Charles Stark Draper Prize
National Academy of Engineering
2101 Constitution Avenue, N.W.
NAS 069
Washington, DC 20418

Dear Mr. Blue:

I write to furnish information relevant to the proposal that the National Academy of Engineering bestow the Charles Stark Draper Prize upon Tracy Hall.

Tracy Hall made an enormous contribution to this country through his invention of the belt apparatus and the first synthesis of diamonds. Later at Brigham Young University he developed and patented other types of equipment for synthesis of diamonds. The products of his equipment had many practical applications including improvement of earth drilling.

I have known Hall since March 1955. I met him then and spent the night at his home. My visit was for the purpose of asking him to join my staff at the Geophysical Laboratory of the Carnegie Institution of Washington. I was Director of the Laboratory and Vannevar Bush was President of the Institution. I had his permission to recruit Tracy Hall.

Tracy Hall chose to accept a position at Brigham Young University. In spite of that, Vannevar Bush took what was a rare action for a C.I.W. President. Without any request by Hall or colleagues in Utah, Bush sent $10,000 of his discretionary funds to Brigham Young University in behalf of Tracy Hall.

Vannevar Bush made excellent decisions on many occasions. His monetary and moral support of Tracy Hall was one of them. The precedent he established led to abundant support from other sources and a continued productive career of Tracy Hall.

Cordially Yours,

Philip H. Abelson

Philip H. Abelson
Science Advisor

UNIVERSITY OF MINNESOTA

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February 6, 1997

Mr. Charles E. Blue
Charles Stark Draper Prize
National Academy of Engineering
2101 Constitution Avenue NW, NAS 069
Wasington, DC 20418

Dear Mr. Blue:

I am very happy to support the nomination of Dr. H. Tracy Hall to be the recipient of the Charles Stark Draper Prize. I was one of those at the General Electric Research Laboratory who independently verified the ability of the technique to produce synthetic diamonds that was developed at that Laboratory. As such, I was knowledgeable about the activity and achievements of the diamond-making team, and specifically about the indispensable contributions of Dr. Hall. Without the high-pressure belt apparatus, of which Dr. Hall was the sole inventor, there would not have been success because at that time there was no other way of achieving the high temperature and pressure necessary to enter the diamond-stable region. That apparatus ushered in a break-through in technology from which the whole world profited and from which it continues to profit. That development is the foundation of what is now a world-wide industry.

Dr. Hall proceeded to demonstrate his great inventive capability by conceiving and building two other completely different high-pressure apparatus, each able to reach the high temperatures and pressures needed to produce diamond. He used these instruments to study the phase relations and behavior of many materials. This represents another first for Dr. Hall since before his work it had not been possible to do x-ray diffraction at high pressures and temperatures.

The impact of his work on high-pressure technology and on the characterization of materials at high pressures and temperatures has been large for both science and industry. The Draper Prize is a fitting acknowledgment of the importance and significance of Dr. Hall's achievements. I express my whole-hearted support of his nomination for that honor.

Sincerely,

Richard A. Oriani

Richard A. Oriani
Professor Emeritus and
Director Emeritus

RAO:jlp

Guy Van Der Schrick
11 Avenue Bastin
B 1200 Bruxelles, 15
02-03-97

Mr. Charles E. Blue
Charles Stark Draper Prize
National Academy of Engineering
2101 Constitution Avenue, N. W., NAS 069
Washington, D.C. 20418

The Attached Support Letter is hereby submitted to the Academy in support of the nomination of H. Tracy Hall for the Charles Stark Draper prize.

GUY VAN DER SCHRICK
DIRECTEUR

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successfully held up the issuing of the patent as this proved to be the key element in diamond making. As was later demonstrated, you can make diamonds out of most anything that has carbon in it, even peanut butter, if you submitted it to the pressures and temperatures such as Tracy's belt design provided.

In an effort to calibrate his belt apparatus, Tracy measured the lowering of the melting point of germanium as a function of pressure. Even allowing for a large margin of error, he demonstrated an apparatus that reached, simultaneously and continuously, the highest pressures and temperatures known in any laboratory. He wrote up the results of these experiments as an internal, company classified, report. I was working on the electrical properties of germanium at the time and I think I supplied Tracy with some high purity germanium to supplement what he obtained from the stock room.

The diamond project, however, was running up high bills with no obvious success in view. The new press was the most expensive piece of equipment that the laboratory had purchased, requiring, I was told, the approval of the top General Electric Company management. A committee made up of the four Department heads at the Research Laboratory was asked to periodically review this project, make suggestions, and, I suppose, eventually make a recommendation of when to terminate it.

It was in this atmosphere that in December of 1954 one of the physicists working on the new press believed he had made two diamonds. Shortly thereafter, diamonds were first made by Tracy in the old press using his belt apparatus. Tracy was able to repeat the making of diamonds even though the runs would often fail because of the unreliability of the old press and cracking of the belt pieces. Also, the required chemistry was not yet understood and Tracy's first chemistry was more complicated than necessary.

To independently verify his results, Tracy asked some others, including myself, to reproduce his results. I was successful and became the first person to reproduce the diamond making experiments of another. This was done on the last day of 1954.

Many people in the past had claimed to make diamonds but were proven to be in error or to be downright frauds. Because of this history, the Laboratory management took unprecedented measures to verify the ability to reproducibly make diamonds before any publicity was given. The top level committee previously mentioned was assigned to verify that the diamond making claims were valid. Since only Tracy's diamond making runs could be duplicated, the committee chose to review his claim.

About the middle of January 1955, the committee asked a staff member from the Metallurgy Department and me from the Physics Department to each independently repeat Tracy's experiments. Our charge was to suspect that all and everyone we dealt with, especially Tracy, were trying to trick us. We went through the most elaborate measures to ensure that diamonds were not seeded in the starting materials and that Tracy could, in no way, secretly seed the results before the completed runs were x-rayed. We were both successful in making diamonds. We reported our results to the committee which they accepted without much

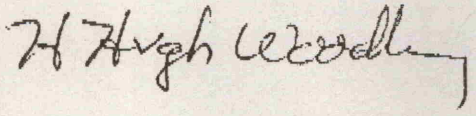
questioning. As far as I know, the committee was not asked to review any other claims to diamond making.

Dr. Hubbard Horn, a senior physicist in my research section, photographed the diamonds for the forthcoming publicity. He described the two diamonds that were supposedly made in the new large press as looking like "diamond chips," that is, fragmented pieces of natural diamonds. Such chips were being used for seeds in the experiments made with the new large press. It now appears that the seeds had been miscounted. It seems ironic that the laboratory management fell into the same errors they were so anxious about and apparently so eager to prevent.

As far as I know, laboratory made diamonds never look like "diamond chips." Diamonds were only reproducibly made in the new press when one of the research assistants made a scaled up version of Tracy's belt apparatus for that press. These diamonds had the same characteristics as the ones that Tracy first made. Likewise, the belt design was used when General Electric began production of diamonds that soon became measured in tons. All of these diamonds were of the type that Tracy first created in December of 1954.

Of course, for patent purposes, all of my diamond making was written up in detail in my laboratory notebook and duly witnessed. This use of laboratory notebooks was strongly stressed at the time. After the publicity release, I noted, in essence, in my notebook that H. Tracy Hall had (1) independently conceived the belt apparatus, built it, and used it to achieve the highest pressures and temperatures attainable at that time, and (2) that with this apparatus, he was the first person to carry out a diamond making experiment that was reproducible by another person. Forty-two years later, I have found no cause to change these statements.

This was an exciting time for the diamond team and for the Research Laboratory. It was also a time of stress because of the conflicting claims and personalities amidst the high publicity. I felt both. But the small part I played as a new member of the Research Laboratory was unique. I have never forgotten it.



H. Hugh Woodbury

CARNEGIE INSTITUTION OF WASHINGTON

GEOPHYSICAL LABORATORY

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[202] 686-2410 (x2470) [202] 686-2419(FAX)

February 14, 1997

Dr. Charles E. Blue
Charles Stark Draper Prize, NAE
NAS-069
2101 Constitution Ave., NW
Washington, DC 20418

Dear Dr. Blue:

It is my great pleasure to support the nomination of Dr. Tracy Hall for the Charles Stark Draper Prize. Dr. Hall, who was the first person to synthesize diamonds in a reproduceable, commercially viable method, is eminently deserving of this recognition.

For the last twenty years I have been a high-pressure researcher at the Geophysical Laboratory of the Carnegie Institution. In our field, the work of Tracy Hall and his General Electric colleagues Francis Bundy, Herb Strong, and Robert Wentorff in making diamonds in giant presses is legendary. I first met Tracy Hall while doing research on a book on the history of high-pressure research (*The New Alchemists*, Doubleday, 1993). Hall, along with many of his former coworkers at General Electric, provided the primary sources for much of the book.

The history proved to be complicated, and was made more difficult by an entrenched GE corporate mythology that teamwork led to diamond synthesis, and that Herb Strong conducted the first successful experiments. This "first man-made diamond," which was enshrined in the GE corporate museum, was recently shown to be a natural fragment. Everyone concerned now agrees that Tracy Hall made the first successful run. Please see extensive details of this important history in my book a copy of which should be part of Hall's nomination documents.

To summarize Hall's remarkable accomplishments, he (1) designed the first and most successful diamond-making press, the belt apparatus; (2) he used that device to synthesize the first GE diamonds; (3) he invented the tetrahedral anvil press and repeated his diamond-making success at BYU; (4) he made significant improvements in the cube-anvil press, and applied that device to producing sintered diamonds. These advances are now the basis for virtually all diamond abrasive synthesis, and they have led to extraordinary technologies, previously undreamed.