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By the Editors of The Energy Daily and Defense Week

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Superconductivity & Intermagnetics General

'People Just Don't Appreciate How Well-Positioned We Are'

Intermagnetics General Corp, the 16-year-old spin-off from the General Electric Co., has won one of the first government contracts to study applications of the recently discovered high-temperature superconductors. The $50,000 contract, awarded under the Pentagon's Small Business Innovation Research program, could lead to an extension amounting to $500,000, according to company officials.

BY RICHARD McCORMACK

The federal government "is studying just what to do" in terms of a research and development strategy, says Intermagnetics General president Carl Rosner. "But we want to go ahead and do something."

For Intermagnetics General, the contract is very important. The publicly owned firm is coming out of a rough year and expects to lose "a lot" of money for its fiscal year ended last month, Rosner told **New Technology Week**. "We were hurt pretty badly by Technicare going out of the magnetic resonance imaging [MRI] business," he said. (Technicare was owned by Johnson & Johnson.) "But we're making a very nice recovery." The company expects its revenues to fall to between $15-16 million, down from about $21 million the previous fiscal year.

Rosner hopes the $50,000 contract will spark some enthusiasm in the financial markets for the company's stock and concentrate attention on the company's prospects for future growth. "People don't appreciate how well-positioned we are," Rosner remarked. "But they'll realize who the real players are—and certainly the award will make people sit up and take note. We are the first company that has received an award."

The company is also still trying to

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Creating An Industry With Proton Accelerators

Paydirt For High Energy Physicists?

A group of high energy physicists is on the verge of introducing a new cancer-treating radiation device that could lead to a new industry that generates hundreds of millions —even billions—of dollars a year in revenues. The new device is a charged particle accelerator, capable of directing a proton beam right on target.

A problem with traditional radiation treatment is that when a tumor is deep within a patient, the tissue between it and the skin must receive huge amounts of radiation—with the cancer receiving a much smaller dose. To make sure the cancer growth gets a large enough dose, radiologists direct high-energy X-rays at the tumor, which could be lodged anywhere in the body or head, from four different sides. They use the term "morbid" to describe the treatment.

It is hoped that the new charged particle beam will reduce this morbidity.

"With a proton beam with the appropriate energy, we can deposit the energy where it belongs—in the tumor—and minimize the dose to the surrounding tissue," says Dr. James Slater from the Loma Linda Medical Center in California. "This should allow us to reach higher and higher doses to that tumor and thereby get a higher control rate as a localized disease."

Slater, who is a member of the

(Continued on page 8)

SDI: The States Shake-Out

BY BILL RANKIN

Forty-three states paid more in taxes to finance the Reagan Administration's Strategic Defense Initiative than they received in research contracts for the program, according to a New York-based public research group that has been analyzing "Star Wars" over the past four years. As a result, funds for research have been "narrowly funneled into a few states, giving America far more losers than winners," says the Council on Economic Priorities.

The council, which is unabashed in its opposition to the administration's "Star Wars" program, argues that money for the initiative would be put to better use to modernize and revitalize basic U.S. civilian industries. "Unless taxes are reallocated, a 'Star Wars' economy could underwrite the most expensive, arcane and strategically destabilizing project in U.S. history," argues Alice Marlin, executive director of the economic council. "Our best hope in correcting the nation's economic ills is by reallocating America's tax dollar and cutting the deficit."

Seven states and the District of Columbia received a whopping 86 percent of SDI contract obligations while paying just 20 percent in SDI taxes, notes the council's recent report, "SDI Costs—Some Win—More Lose." In contrast, 43 states paid 80 percent of all SDI taxes but received just 14 percent of all contract obligations. (The economic council calculates SDI taxes by analyzing the amount of personal federal income tax paid collectively by residents of each state, then SDI outlays are calculated as a percentage of total federal outlays. This percentage is applied to each state's personal federal income tax payments.)

Almost 85 percent of prime contract awards for SDI research between fiscal years 1983 and 1986, says the council's study, were channelled to five states: California, New Mexico, Massachusetts, Alabama and Washington. During this period, California paid 11.8 percent of total SDI taxes but received $1.53 billion—or about 43 percent of the initiative's awards. New Mexico also paid just 4 percent of all SDI taxes and received almost 14 percent (or $488 million) of the awards.

It is easy to determine which states were the "losers" when using this methodology, the council said. These include New York, Illinois, New Jersey, Michigan, Pennsylvania, Florida, Ohio and Georgia. Georgia appears to fare the worst. According to the council, the Peach State paid almost 7 percent of all taxes used to finance the SDI program but received only .2 percent (or $8.8 million) of the program's research awards. Other states such as Idaho, North Dakota and Wyoming received no SDI money at all.

SDI, which will perhaps be the largest military program ever undertaken, has already received $9 billion in funding over the past four years. President Reagan is now requesting another $39 billion over the next five years and cost estimates for the entire program range from $400 billion to $1 trillion, according to the council. "In today's prices, that's more than eight times the price of putting a man on the moon ($80 billion); more than twice the cost of the Vietnam War ($300 billion from 1965-1975)," Marlin noted. "For the average American household, this could mean as much as $5,000 to $12,000 in extra taxes....SDI will be a severe drain on our economy. As an interim step while it is determined whether or not SDI will work, CEP recommends reducing the SDI budget for fiscal year 1988 to no more than $1.4 billion a year."

U.S. Manufacturers: 'Myopic'

Most U.S. manufacturing executives still view other U.S. companies as their primary competition, despite well-publicized concern over American manufacturing's global competitiveness, according to a survey released recently by the accounting firm of Coopers & Lybrand.

The survey, conducted by Louis Harris and Associates, also revealed that the executives remain generally optimistic about U.S. manufacturers' prospects in the growing global marketplace.

"The optimism expressed by these top manufacturing executives reveals a certain myopia," says Henry Johansson, chairman of Coopers & Lybrand's Manufacturing Industry practice. "Rather than taking a global view, the executives still see the main competition coming from across the street."

The Coopers & Lybrand survey also revealed the following:

- 75 percent of the executives said advanced technologies, such as computer integrated manufacturing, are being added only on a modest scale;
- While large increases in implementation are predicted over the next five years, approximately one-half foresee only limited application of technology.

Debunking A Technology Myth

Most people in the U.S. think that installing labor-saving technology in manufacturing plants leads to increased unemployment. They're wrong, says a panel convened by the National Academy of Engineering. "Technological change is an essential component of a dynamic, expanding economy," says the panel, which noted that the most recent report on the topic is more than 20 years old.

"Much of the job displacement of the past seven years does not reflect a sudden increase in the adoption of labor-saving innovations," the panel said. Instead, most of the jobs lost were the result of the sluggish world economy and the slow integration of new technologies by U.S. manufacturers.

The engineering panel also found that employers give very little advanced notice to workers that are getting laid off. For instance, white collar employees receive, on average, 14 days' notice before they're out the door. Unionized blue-collar workers receive 7 days' notice. And non-unionized blue-collar workers, have but two days to pack their bags. In a recent Government Accounting Office survey, about 30 percent of those responding said they received absolutely no advanced notice of a plant closing.

Upper Midwest States Team Up On SSC Site Proposal

The governors of North Dakota, Minnesota and Iowa have agreed to work with South Dakota in seeking the $4.4 billion Superconducting Super Collider in a plan that South Dakota Governor George Mickelson says could save the government $1 billion.

Mickelson contends that the upper Midwest is "very much in the ball game" with its plan to jointly sponsor the world's largest atom smasher. He met with congressmen from the region recently to discuss the regional plan to urge their support for the collider.

South Dakota's legislature will convene in special session July 16 to work on the regional proposal. Its work will include making sure land is available for the collider.

Under the South Dakota plan, the collider would be built near Howard, S.D., between Sioux Falls and Mitchell. Bordering states will take part in an interuniversity advisory board to gain use of the collider and there will be a board to advise businessmen of possible contracts. The state also promises to invest $1 million in seed money in a regional research fund for superconductivity and high energy physics.

Mickelson said the regional plan could cut $1 billion from the price of the collider by using the lower-cost "cut and fill" construction method and lower utility costs to run the collider. He declined to say how low a rate utilities are offering.

Congress is rewriting the rules somewhat. House-Senate negotiators put an amendment into a supplemental appropriations bill saying the department should not consider financial incentives in picking the site. However, the impact was unclear since states still can list their incentives.

Mickelson said the provision will not hurt the regional proposal. The limitation will keep rich states from trying to "buy" the collider, he said.

The Department of Energy will judge the proposals on financial and in-kind contributions offered by the states, DOE said late last month. "Any financial or in-kind contributions offered by the proposer, other than the cost of the land, will be considered," says DOE. "Proposers are given the opportunity to offer financial and other incentives to defray the cost of construction and operation of the SSC." DOE says that substantial savings could be achieved through "preferential treatment," such as reductions in utility rates, and road maintenance costs.

Meanwhile, the Department of Energy says that it will not release copies of proposals. However, the department "has no objection to a proposer releasing its proposal to others."

What does DOE plan to do with the SSC upon decommissioning? "This is unknown at this time," the agency says.

—Staff writers and wire services (UPI)

Technology Feats For EPRI:

Thyristors

An advanced thyristor that is protected against surges in electric voltage has been developed and tested by the Electric Power Research Institute. Until now, thyristors triggered by a light source have required costly overvoltage protection, resulting in increased losses. This problem is preventing some potential users from using thyristor-based equipment, says EPRI. In work performed by Westinghouse Electric Corp. at a Minnesota Power Co. substation, EPRI was able to develop the base technology for the new thyristor. "These developments may give the self-protected light-triggered thyristors a competitive edge over electrically [triggered] devices," says EPRI. Thyristors are semiconductors that allow electricity conduction in one direction, rectifying AC to DC current. For more information contact EPRI. (EPRI report EL-5125. Call 415/965-4081.)

Laser Doppler Vibration Meter

Analyzing the vibration of machinery and equipment that is operating under extremely high temperatures has been tough to do, until now. Equipment vibration is often an early sign of damage. Normally, vibration is measured by means of "proximity probes." But these often fail when temperatures exceed 500 degrees F, and are subject to electrical interference. As a result, EPRI, through its contractor, General Electric Company, has developed a laser Doppler measuring device that can measure the vibration of equipment from up to 50 feet away—a great device for use in a nuclear power plant, for instance, where some components are not easily approachable. The so-called vibrometer sends a low-power helium neon laser beam to the suspect component and measures vibration, amplitude and frequency. This new technology "offers unique capabilities for rapidly surveying entire machines without shutting them down," says EPRI. (EPRI report CS-5031. Call 415/965-4081.)

Chemical Vapor Deposition For PV

EPRI has developed an improved chemical vapor deposition process for producing amorphous silicon photovoltaic cells. The process produces cells 100 times faster than the traditional glow discharge method, which produces the highest quality thin-film amorphous silicon solar cells (more than 11 percent efficient). But there are problems with EPRI's new fabrication method. "The relatively high substrate temperature required to obtain the best chemical vapor deposition films might pose problems for solar cell manufacturing by increasing production costs," EPRI says. (The amorphous silicon films are deposited on substrate held at 450-520 degrees C.) The chemical vapor deposition process could also limit the efficiency of the solar cells. "Nevertheless, the extremely high deposition rates and relatively good quality material obtained reinforce EPRI's positive projections for thin-film amorphous alloy solar cells," EPRI concludes. (EPRI report AP-5166, 415/965-4081.)

Intermagnetics General... (From page 1)

decipher the federal government's game plan with respect to superconductivity. Rosner, who was just appointed to a National Academy of Sciences panel to study the recent breakthroughs, says he is "trying to sort out" other government opportunities. "We have a lot of credibility and have been involved in this activity for a long time and maybe that's why it was easy [for DOD] to pick us for this award," he said. "It may be harder to pick someone else."

"I'm sure the government will not rely on a single source for the magnets. I'm sure they'll have two or three suppliers."

The Guilderland, New York-based company, has redirected some of its research efforts into the new generation superconductors. "But we realize that there is so much effort going on that we can't hope to do everything in every area," Rosner said. "We're trying to keep track of what others are doing."

The company's own effort "will be focused on identifying the most appropriate superconductor, selecting the most reasonable methods for superconductor formation and defining an appropriate multi-filament process," Rosner added. "To be technically and commercially useful, these materials will most likely have to be incorporated into practical multi-filament configurations."

In its more traditional lines of business, Intermagnetics General expects the Department of Energy's proposed Superconducting Super Collider will be good for business. "We feel we are in a very good position having supplied the lion's share [90 percent] of the [superconducting] material for the Fermilab [Tevatron] project," which was commissioned three years ago, Rosner said. "Again, it gives us a good head start over everyone else."

Adds Merle Ross, who is in charge of the company's investor relations: "The SSC could be fantastic. The money involved when they really get going will be several hundreds of millions [of dollars] in superconducting materials." Even if the company receives contracts to supply only a small portion of that amount, it would be a huge influx of business.

Will the new oxide superconducting materials have an effect on the SSC? "They are of insignificant importance," Rosner says. "The work that has been going on for the past five years for the SSC would have been all for naught, and we would have to wait another five or ten years to again set the stage for a new version [SSC]."

Could Intermagnetics General set up an assembly line to supply magnets for the SSC given the fact that Westinghouse has declared that it wants to do the job alone? "Absolutely," Rosner responded. "Westinghouse is a good candidate to supply the magnets, as are other people," he said. "And in fact, I'm sure the government will not rely on a single source for the magnets. I'm sure they'll have two or three suppliers."

Rosner is also bullish on the prospects for the MRI market, which is about a $500 million-a-year industry and constitutes the company's primary market. "The industry is not making money yet, but there is certainly a market," Rosner said. Of the 1,000-or-so magnets that have been supplied to MRI machines, Intermagnetics General has delivered about 100.

Company officials peg the MRI market at between 300-400 systems a year (at a cost of between $1 million and $2 million per machine). Projections show sales of MRI diagnostic systems increasing to 600 a year. Intermagnetics General supplies the magnet that is wound and has all the protection equipment and the electronics to start it up and stop it. Two of the 10 MRI manufacturers—GE and Siemens—make their own magnets, says Ross. "The other eight are up for grabs."

But Intermagnetics General really took a beating when Technicare pulled out of the market. The company's stock was trading at $10 a share when that happened last year. It's now down to $5. "But frequently there is no relation between the price of the stock and what the company is doing," says Ross. Right after the company went public in 1981 and when it needed money to pursue the MRI market, the company's stock zoomed from $6 to $23 a share within 18 months. "We were losing $4 million and our revenues were only $4 million," Ross said. "Twenty-three dollars a share with those losses and revenues is not very realistic."

Cray Research Selling Computers

Cray Research Inc. is on a tear. During the last week of June, the Minneapolis-based company announced the sale of three of its multi-million dollar supercomputers. The lucky recipients: the U.S. Army Strategic Defense Command, which spent $7 million on the Cray computer; Unisys Corp., which purchased a $20 million system for the U.S. Air Force to be installed at the Kirtland Air Force Base in Albuquerque, N.M. (This machine will be used to assist in research ing systems for the Strategic Defense Initiative.); and Boeing Computer Services, which purchased a $10 million Cray for the State of Alabama to support scientific and engineering research by Alabama's industries, government agencies and state universities. Since being incorporated in 1972, Cray has sold 175 supercomputers. So far this year the company has sold an estimated 25 new systems, according to a company spokesman. Last year, the company sold 35 new systems and reinstalled 10 used ones. The company hopes to sell 45 supercomputers this year, and overhaul 10 used machines. Cray had revenues last year of $597 million, and pumped 15 percent of that back into research and development. Its net income was $125 million ($3.99 per share). The company's stock has been on a bit of roller coaster lately: after hitting a high of $135 per share earlier this year, it has dropped down to $100. Cray Research has 4,000 employees.

Physics Director For Physics Institute

The American Institute of Physics has a new director of its physics program: Dr. John Rigden, who has been editor of the American Journal of Physics since 1978, and is a professor of physics at the University of Missouri. He succeeds Dr. Louis Slack, who is retiring from the New York-based institute after 20 years of service.

Keeping Hughes Aircraft On Its Toes

Hughes Aircraft Company's Research Laboratory has a new leader: Dr. Eugene Gordon, a noted opto-electronics scientist who spent 25 years of his career with Bell Laboratories. Gordon succeeds George Smith, who is retiring after being with Hughes for 35 years.

Gordon takes control of one of the country's leading industrial research facilities which employs 500 scientists and support personnel. It sits above the Pacific Ocean in Malibu, a half-hour drive from company headquarters.

Gordon's specialties at Bell Labs mix well with the research Hughes conducts, say company officials. At Bell, Gordon was involved with gas discharge physics, microwave tubes, gas and semiconductor lasers, imaging and display tubes and optical and electron-beam lithography. Hughes Research Lab is best known for building and operating the first laser in 1960, a program in which Gordon has participated.

The Hughes research facility is funded 50 percent by the company and 50 percent by outside contracts, mostly from the Defense Department and NASA. The company does not disclose how much it spends on R&D, nor the percentage of its revenues that goes into R&D activities, nor the split between civilian and defense related research. "Our research is in line with the company's distribution of work," says spokesman Bill Herrman. "And the largest single customer is the U.S. military." Hughes is the largest industrial employer in California, with 75,000 on its payroll.

"When General Motors bought us two years ago, we added only about a 10 percent blip in their employment," says Herrman. "And we thought we were a big company."

With its abundance of work in defense electronics, is the company concerned about the Japanese competitive threat? "I don't think we would say we are concerned about losing the edge because they and our competitors [in the U.S.] keep us on our toes and provide us an incentive to keep at the forefront," says Herrman. "Therefore, it is very important for the research lab to keep up."

To help do that, Hughes is expanding the facility by adding 90,000 square feet to the already existing 140,000 square feet of space. The addition should be finished by early next year.

"We've been keeping up with microelectronics developments," says Herrman. The company last year disclosed the world's fastest integrated circuit, an 18 gigahertz gallium arsenide divider circuit. Another of the company's accomplishments: the aid in the development of the next generation of integrated circuits, submicron devices and machines to build them. "We've developed lithography machines that are now [capable of producing] sub half-micron dimensions," says Herrman. One machine was developed under the Very High Speed Integrated Circuits program. The results of that effort were turned over to Perkin-Elmer, which is now making and selling the machines.

Hughes Research Lab is also working on developing ultra-small micro electronics, new electronic materials, gallium arsenide for use in millimeter wave, microwave and high frequency solid state devices, fiberoptics and integrated optics, infrared sensors, information sciences and artificial intelligence systems.

Hughes Aircraft had sales of $6.9 billion last year, up from $6.2 billion in 1985, an 11 percent gain. In 1986, the company received $6.8 billion in new orders and had a backlog of $10.5 billion.

NAS's Superconducting Panel

Dr. John Hulm, director of Westinghouse Electric Corporation's research and development division has been named to head a 25-member National Academy of Sciences panel that will produce a report on the recent breakthroughs in superconductivity. The review was requested by National Science Foundation director Dr. Erich Bloch, and is being conducted on an accelerated schedule—a completion date is scheduled for late August. "We have two charges," explained John Clement of NAS's Committee on Science, Engineering and Public Policy. The first is to summarize the state of the science and technology. The second is to look at the barriers impeding commercial applications and how those barriers can be overcome. Given the short time period of the report, "it's hard to predict just how far the panel will get in this debate," says Clement. "It depends on how much consensus we get on the science." The other superconductive luminaries on the panel include:

- **Neil Ashcroft**, Department of Physics, Cornell University
- **Roger Boom**, Professor, Nuclear and Metallurgical Engineering, University of Wisconsin-Madison
- •• **Judy Bostock**, Nuclear Energy Branch, Energy and Science Division, Office of Management and Budget, Executive Office of the President
- **Kent Bowen**, Massachusetts Institute of Technology
- **Robert Cava**, Library Director, Colleges and Universities, AT&T Bell Laboratories
- **Paul Chu**, Program Director of Solid State Physics, National Science Foundation
- **John Clarke**, Department of Physics, University of California, Berkeley
- **Marvin Cohen**, Professor of Physics, University of California, Berkeley
- **Doug Finnemore**, Associate Director, Science and Technology, Ames Laboratory
- **Eric Forsyth**, Brookhaven National Laboratory
- **Theodore Geballe**, Department of Applied Physics, Stanford University
- **David Larbalestier**, Co-Director of Applied Superconductivity, University of Wisconsin-Madison
- **Charles Laverick**, of Patchogue, N.Y.
- **Alex Malozemoff**, Research Staff Member, IBM Corp.
- **James Parker**, of Penn Hills, Penn.
- **David Pines**, Professor, University of Illinois, Loomis Laboratory of Physics, Urbana Ill.
- **Carl Rosner**, President, Intermagnetics General Corp.,
- **John Rowell**, Assistant Vice President, Solid State Science and Technology Research Lab., Bell Communications Research
- **Arthur Sleight**, Central Research & Development Dept., E.I. duPont deNemours & Co.
- **James Smith**, Los Alamos National Laboratory
- **Masaki Suenaga** Department of Applied Sciences, Brookhaven National Laboratory
- **Maury Tigner**, Lawrence Berkeley Laboratory
- **Michael Tinkham**, Physics Department, Harvard
- **John Williams**, Head, Magnet Technology Division, National Magnet Laboratory, Massachusetts Institute of Technology

A New Technology Week Su

How Electric Utility View Superconductiv

How do electric utility company chief executive officers view the potential applications of the new high temperature ceramic superconductors for their industry? A survey by *The Energy Daily* and *New Technology Week* reveals that CEOs, on average, believe there is great potential for the new materials but that their implementation is far into the future. At least one thing is certain: utility CEOs have a wide range of thoughts about the new and popular technology.

We asked if, with the use of superconducting transmission lines, utility CEOs thought there would be the creation of a national grid.

Some executives bluntly dismissed such a possibility. "Never," responded William McCormick, chairman of Consumers Power Co. "It's not cost-effective. Regional grids do the job." Another leading utility executive, A.W. Dahlberg, president and CEO of Southern Company Services, agreed with McCormick's view that the new technology would not lead to a national grid.

"I can't imagine a superconductive national grid within the next 30-40 years," offered Walter McCarthy, chairman of Detroit Edison. "It will be a long time before an oxide of barium, combined with a rare earth such as lanthenum or yttrium and copper could be employed in a transmission network. All of us will be a lot older by the time that comes to pass." McCarthy also believes that such a network "is much more dependent upon whether or not the nation will have the economic strength to build [it]."

Pacific Gas and Electric Co. also believes that such a network is "unlikely." Superconducting transmission lines might not be economically viable "even if technical breakthroughs allow for non-refrigerated overhead applications," says Gregory Rueger, PG&E's vice president for electric resources planning and development. "If the technology continues to require cooling and undergrounding, the economics would be even less unfavorable."

Ontario Hydro agrees. "If superconductors ever become practical for bulk electricity transmission, it will be as underground transmission," responded J.A.R. Service, the company's transmission system planning manager. "Even with current technology, underground cables are 10 to 20 times more expensive to install than overhead transmission lines to transfer the same amount of power....Zero losses with superconductors would make up for some of the capital difference, but certainly not all of it."

One prominent Texas utility executive, who asked that his name not be used, said: "The establishment of a na will be determined by Superconductivity co will not be the driving

In contrast to tl investor-owned utiliti are much more optim national grid.

One such executive of the Tennessee Va "Yes, I foresee the e grid, even without su appears there will be the availability of pov northern hemisphere grid should be in ex Dean predicted. Sup also help TVA's ov because the utility m within its system. "Al concentrated in the Dean explained. "An to move this power to with minimum line lo

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But while there is national grid, there i will happen if it m lines.

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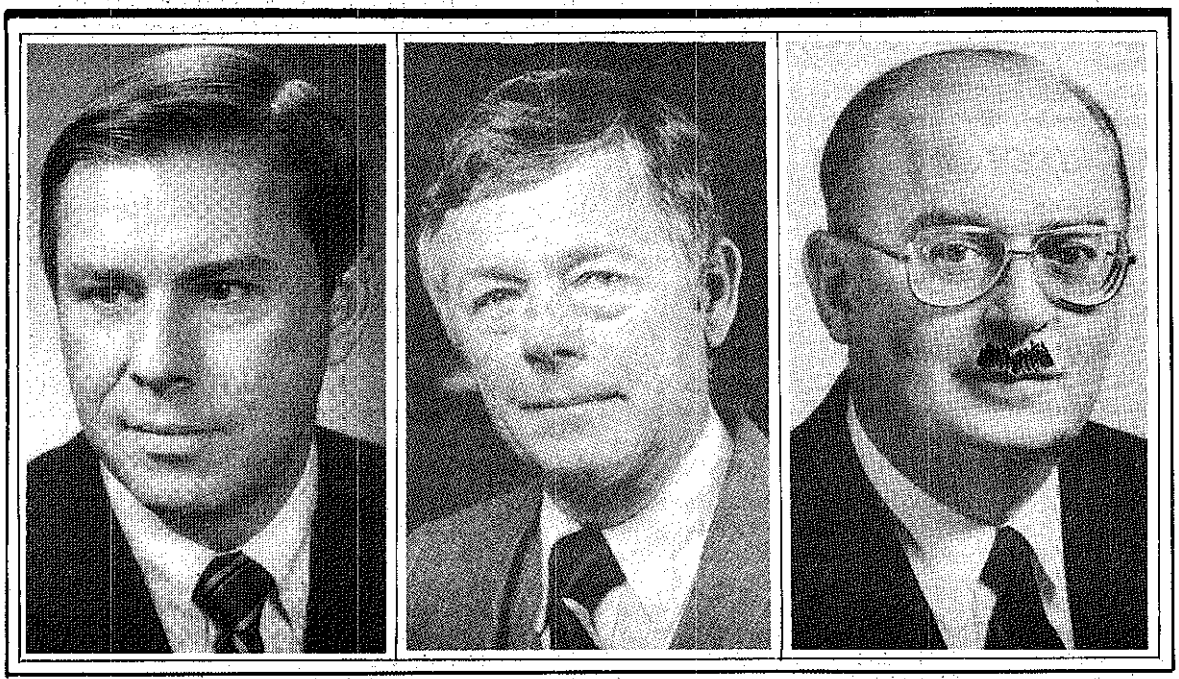
TVA chairman Dea "most unlikely unless transmission economi chance of burying right-of-ways, he say mental objections to ever, "since most tolerate outdoor bill visual pollution is general public," the S



From left to right: Consumers Power's McCormick says a superconducting national transmission grid "is not cost-effective;" TVA's Dean differs, saying that he sees a national grid by the turn of the century, "even without superconductivity;" and McCarthy of Detroit Edison predicts that electromagnetic storage batteries that provide peaking capacity "are by far the most likely initial [superconducting] installations."

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s that burying lines is rconductivity changes astically." There is a lines along highway view of the environ- al pollution." How- e country seems to s, it is apparent that at important to the rner added.

PG&E "probably can't justify underground reconstruction of existing circuits based solely on the reduced transmission losses obtained," says Rueger. On the other hand, Southern Company president Dahlberg believes there will be "some" undergrounding.

Detroit Edison's McCarthy takes a rational approach to the question. "There is no need to talk about burying superconductive lines until somebody proves that we can have superconductivity at a reasonable cost," he writes.

Ontario Hydro will wait and see. "While we are going to keep a watching brief, we are not going to change our transmission planning and design philosophies just yet," the company says.

We also asked executives whether they thought it would be better to build new superconducting transmission lines rather than building new generating facilities.

"Even though the reduction of losses would reduce the requirement to add additional generation, the cost to achieve superconducting transmission could easily exceed the cost of new generation, especially if it requires cryogenic applications," says the Texas utility executive.

"In the short term, some regional efficiencies may be achieved by transporting power from pockets of excess capacity to markets with excess load," says PG&E's Rueger. "But in the longer term, generation and its associated costs must still be borne regardless of the capacity and efficiency of the transmission system." Moreover, even if superconducting lines enable utilities to build generating plants far from consumers, it still may not be economical. "There may be a large potential for hydro development in Alaska," Rueger explains. "But even if the generation costs were reduced to zero, the cost of transmission would still make it uneconomic to develop for continental load centers." The cost of new generating facilities is $400 per installed kilowatt for a gas turbine, $700 for a combined cycle plant, and $2,400 for a coal-fired plant, he says. New transmission costs are estimated at $.50 per kilowatt mile for a 500-kilovolt line. Undergrounding a superconductive line could increase this cost to much more than $5.00 per kilowatt mile, says the PG&E executive.

Bonneville's Jura thinks that superconducting devices "could be used to defer or avoid the construction of generation resources....To date, we have not seen analysis that would lead us to any conclusions. It is a subject in which we have a great deal of interest."

Consumers Power chairman McCormick sees the costs of adding superconductive transmission as opposed to new generating capacity as "comparable."

What about superconductive storage batteries?

"Perhaps large users could install superconducting storage rings, but this is a long way from becoming a reality," says the Texas utility executive. Moreover, a superconducting battery probably won't help improve the reliability of utility systems. "Blackouts and brownouts are rarely a function of insufficient power," he points out. "Rather, they result from random events such as storm-damaged lines, accidents or transformer failure."

Others see storage as being superconductivity's most sudden success. "Storage is the most likely candidate for application of superconductivity in utility systems," declares PG&E's Rueger. Storing electricity during off-peak periods for peak use "can mean large dollar savings," he comments. The technology would help prevent brownouts and blackouts "only to the extent that the storage represented additional generating capacity and therefore increased reliability."

Jura agrees. "Among the early applications of superconducting storage devices will be the ability to enhance control and reliability of power systems," he writes.

"I think that electromagnetic storage batteries to provide peaking capacity are by far the most likely initial installations," adds Detroit Edison's McCarthy.

But this optimism isn't shared by TVA's Dean, who says: "Since chemical storage (batteries) is

(Continued on page 12)

Projected Implementation Times For Various Superconducting Devices

(Based on interviews with three Japanese experts.)

Application	K. Tachikawa (Tokai U.)	S. Tanaka (U. Tokyo)	N Makino (Mitsubishi Res.)
Magnetic levitated train	~2000	1995-2000	1995-2000
S.C.-driven ship	~2000	~1997	1990-1995
Power line	1995-2000	~2000	~2000
Power generator	~2000	~2000	1995-2000
Power storage	~2000	~2000	1990-1995
Josephson device	~1990	1990-1995	~1990
IC package/ substrate	~1990	1990-1995	1990-1995
S.C. semicon. IC	~1990	1990-1995	~1990
Magnetic sensors	~1990	1995-2000	~1990
IR sensors	~1990	1990-1995	~1990
NMR-CT	1990-1995	1990-1995	~1990
Magnetic shielding	1990-1995	now	1990-1995
Toys or kits	1990-1995	~1990	1990-1995
S.C. magnet (fusion)	~2000	~1995	1990-1995

Source: Nippon Keizai Shimbun (May 18, 1987)

In contrast to the comments made by utility CEOs, the accompanying chart—with predictions from three Japanese experts—demonstrates a bit of a more optimistic view of superconductor applications and commercial availablity.

Proton Accelerators...

(Continued from page 1)

Proton Therapy Oncology Group, is working with physicists at the Fermi National Accelerator Laboratory and the Lawrence Berkeley Laboratory to develop a new modular positron accelerator to be installed at Loma Linda. If successful—and most people involved with the project think it will be—the accelerator could be a boon to the company that has been selected to commercialize the technology: Science Applications International Inc. (SAI).

"We are developing a contract with [SAI] to become the major industrial player so that it can be carried through to others," says Slater. "I suspect that [other medical facilities] that want this technology will prefer to work with industry at this point and get something up with a lot less time and effort. It's been an enormous task."

Enormous as the effort has been, the proposed proton synchrotron accelerator is still not ready for installation. Slater says he hopes to have the machine up and operating before 1990. Loma Linda has just started soliciting funding for the project.

Even the technology's cost has yet to be nailed down, although some close to the project loosely estimate that it will cost about $36 million. "We're not certain about the personnel it will take to maintain this," adds Slater. "There is a great difference of opinion as to how many physicists, technologists, dosimitrists and physicians will be necessary to do it."

The goal is to be able to install the machine and provide therapy at a price that would be supportable by insurance companies, particularly Medicare. "The more patients we can treat in one hour, the lower the cost for each patient," Slater said, sounding more like an industrialist than a doctor.

Still, getting patients in and out of the facility as fast as possible is one of the biggest technical challenges of the project. "By far the largest time factor involved in treating the patient is setting him up," Slater explains. In order to reduce this time, the entire facility will be electronically automated. Patients will be fitted in a mold, since the treatments can be administered 40 to 50 times over the course of months. And the beam will be directed at the patient who is lying prone by means of a 360-degree rotating gantry. "Getting a device that will rotate 360 degrees while maintaining a one-to two-millimeter isocenter is not easy," admits Slater.

But moving the gantry around is easier than manipulating a patient for a number of reasons: it would be highly stressful for a cancer patient to be placed in a rotating device that would move him to a fixed beam, and it's also possible that organs and the cancer would move out of alignment and the beam would hit the wrong area.

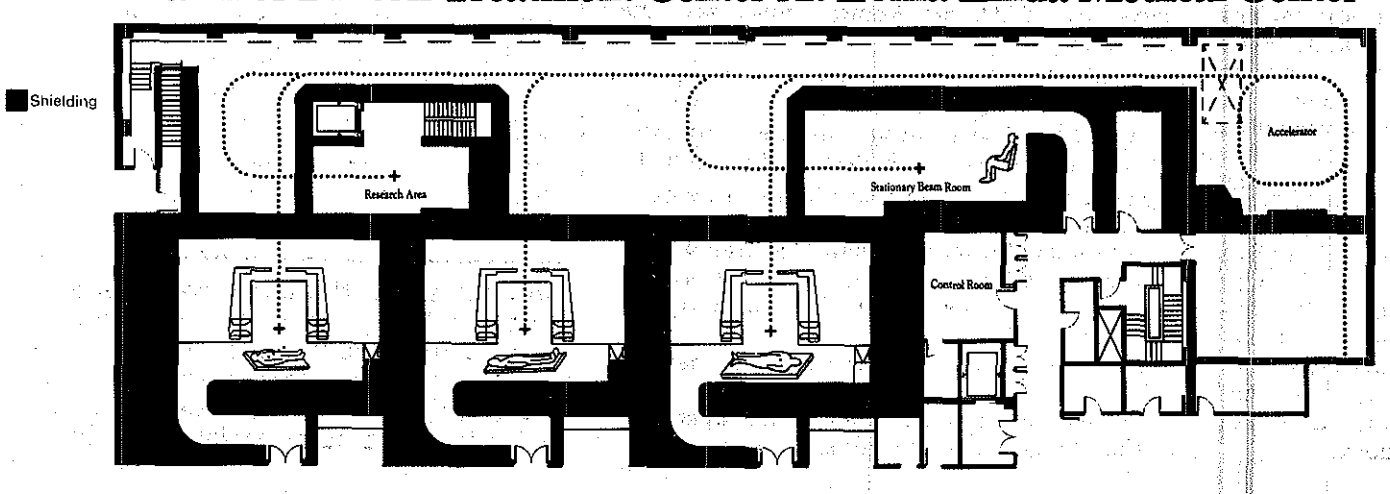
How many of these facilities could be installed? "There is a great difference of opinion on that," Slater reponds. "A lot depends on how successful this project is. And if it is successful, there will be a large market." Harvard University is planning a similar facility, "and other universities are in the talking stage of developing proton facilities," Slater reports. "Five in this country could satisfy [demand] until it is proven effective." Others have estimated that as many as 100 facilities could be installed in the U.S. and countless others overseas.

The entire technology is made possible by the advances high energy physics have made in the medical profession during the past two decades, notably the breakthroughs in magnetic resonance imaging (MRI) and computer-assisted tomography (CAT) scans. "In 1970 we had some excellent results from using charged particles on cancers," Slater recalled. "But we couldn't visualize the tumors without a great deal of accuracy." MRIs and CAT scans changed that in the mid-1970s, "but even though we could then visualize the tumor, [researchers didn't know] how to aim the beam with precision and hit the target." That's changed, thanks to computers.

Why go with a proton accelerator? Because protons are the least expensive particle to use, says Slater. "Protons have the same biological effect that X-rays do, so it gives us a head start because we know their biological effects on the surrounding tissue." The effect of heavy ions isn't very well known. "The time will come when it will be tried with neutrons," Slater remarked. But using neutrons and heavy ions will require more research.

"These [new accelerators] are very, very expensive, almost to the point where they may be more costly than it's going to be worth," Slater concludes. "To jump into something more expensive, I don't think we can do that."

Floor Plan For Proton Treatment Center At Loma Linda Medical Center



Fermilab: Midwife To A Technology

When it comes to creating a new industry using proton accelerators, the people who will take much of the technical credit are the scientists at the Fermi National Accelerator Laboratory. Without the lab's resources, the planning of the facility at the Loma Linda Medical Center would not be progressing. "The only thing that will stop this facility from becoming a reality is if Fermilab has to withdraw its participation," says Dr. John Slater of the Loma Linda Medical Center.

The Loma Linda group will pay Fermilab $6 million in fees for technical services and expertise. "This goes to salaries for people who are working on the project, and most of them are not working on it more than 10 percent of their time," says Fermilab's deputy director Dr. Philip Livdahl. "And everyone has got another job." The total cost of the machine and components is $15 million. The total cost of the facility is an estimated $36 million.

Fermilab, which is located near Chicago, has worked closely with the medical community since the lab's inception in the 1960s. The lab, after discussions with Chicago-area physicians, installed a neutron therapy facility. "In retrospect, it might have been better to go with a proton facility," Livdahl comments. "But on the other hand, the neutrons have been thoroughly researched at Fermilab." In the past 11 years, more than 2,000 patients with cancer have been treated at the neutron therapy device, "which has been shown to be particularly beneficial for soft tissue tumors, particularly in the head and neck and prostate and vaginal areas," says Livdahl.

But Fermilab has learned a fundamental (retail) business lesson by having a stand-alone medical facility: "To have a facility that is far out of the city and away from the medical schools treating special cancer cases, makes it difficult for the research physicians to come to treat specific patients and then return to the city," Livdahl explains. "The referral of patients was not high enough to justify a multi-treatment facility."

For the Loma Linda facility, the high energy physicists at Fermilab wanted to install a superconducting machine. "But we looked at the development costs that would be associated with developing a system that was entirely superconducting and it was far too large a number," Livdahl said. "It was far more practical for a warm magnet machine, despite the fact that our recent experience with the superconducting synchrotron at Fermilab [the Tevatron] was so encouraging."

There are great differences between the two types of accelerators. The superconducting machine is absolutely stable. "In terms of what you tell it to do, that is exactly what it does," says the Fermilab executive. That's not the case with an iron dominated machine "because for some reason or another, the iron tends to remember its past history and if you put it into a mode where it's not doing quite what you think it should be doing, it will remember that and it will keep on doing these weird things....That's characteristic of almost all iron machines, it doesn't matter if its a cyclotron or synchrotron or anything."

The Fermilab researchers ran into a second problem with a superconducting machine for the Loma Linda Medical Center. Since the magnets were going to be rotated 360 degrees along a horizontal axis, it leads to problems. "If we spend the next couple of years on it, we would be able to solve the mechanical engineering problem," says Livdahl, adding that the extra couple of years and millions of dollars would have been hard to come by.

Early in the Loma Linda project, the managers at Fermilab decided that it was inconsistent with the lab's mission to proceed with the building of more than one machine. "We are not a manufacturer and are not in business," says Livdahl. "So our secondary goal is to transfer the technology and the designs so that they could be replicated for other institutions." Fermilab will apprentice two employees from Science Applications International Inc., which was selected after 40 firms were invited to a presentation on the technology and after six firms submitted bids to become the technology transfer agent.

"This has gone reasonably well," Livdahl observed. "It hasn't gone as rapidly as we thought it would. Science Applications selected one engineer and one physicist who are very familiar with Fermilab—they've worked there in the past. So we do have a running start despite the fact that they came in the door fairly late."

If Fermilab officials are so committed to the technology, why have they not tried to make a business out of it? "We could do this only if we made the commitment to leave the laboratory," Livdahl responds. "And that's the alternative: You cannot do it and be part of the lab at the same time."

Moreover, "none of us have enough experience to be entrepreneurs," Livdahl continued. "The experience we've seen with colleagues who have formed companies on their own is that they didn't end up owning those companies anyway. They were really owned by the people who put the money into it."

From his perspective, is there more emphasis at the labs to spend their time on projects that have potential commercial applications, such as the positron accelerator? "I have to say, no," Livdahl said. "I don't think so. Not at Fermilab. It might be a focus at the multi-purpose laboratories. But at Fermilab, everyone is so inundated with high energy physics demands that they don't really have time to think about anything else. With this one exception. And sometimes we have trouble getting enough time to think about this, too."

Call For Your Space Station Report

The Space Station is going to be a dandy of a project, says a National Academy of Sciences panel that just finished a assessment of NASA's cost estimates. "The management of Space Station integration is made more difficult by the complex interfaces among the four NASA centers doing the bulk of the work on the Space Station, and especially those between Johnson and Marshall," says the report. "The integration challenge presented by this combination of factors is unprecedented." This is but one of many foreseeable problems that the panel outlined in its seven-page assessment, which is free to subscribers by calling our offices.

Educational And Nonprofit Institutions Receiving Defense Department R&D Contracts For More Than $25,000

Last year, U.S. educational and nonprofit institutions received $2.66 billion in prime contracts for research, development, test and evaluation. This was 7.3 percent more than the previous year when DOD awarded the group $2.47 billion.

Academy of Applied Science, Concord, NH	$254,000
The Aerospace Corp, El Segundo, CA	301,781,000
Agouron Institute, Placentia, CA	425,000
Alabama A&M University, Normal, OK	50,000
Albany Medical Center Hospital, Albany, NY	270,000
American College Testing Program, Iowa City, IA	143,000
American Dental Association, Chicago, IL	35,000
American Fdn. Biological Research, Rockville, MD	356,000
American Institute Biological Science, Washington, DC	597,000
American Red Cross DC Chapter, Washington, DC	200,000
American Soc. for Engineering Educ, Washington, DC	2,156,000
The American University, Washington, DC	63,000
American Inst. Res. Behaviour Sciences Palo Alto, CA	371,000
Amherst College, Amherst, MA	133,000
Analytic Services Inc, Arlington, VA	17,009,000
Arctic Institute, Washington, DC	33,000
Argonne National Lab, Argonne, IL	419,000
Arizona State University, Tempe, AZ	2,466,000
Art Intlg Research Institute Texas Inc, Austin, TX	37,000
Atlanta University, Atlanta, GA	500,000
Auburn University, Auburn, AL	4,815,000
Battelle Memorial Institute, Columbus, OH	35,867,000
Baylor University, Dallas, TX	1,124,000
Bigelow Lab for Ocean Sciences, Boothbay Harbor, ME	166,000
Black Hawk College, Rock Island, IL	34,000
Blood Center Southeastern Wisconsin, Milwaukee, WI	70,000
Boston College, Newton, MA	1,377,000
Boston University, Boston, MA	4,804,000
Brandeis University, Waltham, MA	174,000
Brigham & Womens Hospital, Boston, MA	291,000
Brigham Young University, Provo, UT	3,712,000
Brown University, Providence, RI	6,125,000
California Institute of Technology, Pasadena, CA	9,833,000
California State University, Long Beach, CA	1,932,000
Carnegie Mellon University, Pittsburgh, PA	35,594,000
Case Western Reserve University, Cleveland, OH	3,663,000
Catholic University of America, Washington, DC	1,641,000
Central Blood Bank Pittsburgh, Pittsburgh, PA	98,000
Central State University Oklahoma, Edmond, OK	90,000
Chicago Medical School, Chicago, IL	152,000
The Citadel, Charleston, SC	46,000
City of Hope, Duarte, CA	53,000
City University of New York, New York, NY	926,000
Clark University, Worcester, MA	44,000
Clarkson University, Potsdam, NY	1,067,000
Clemson University, Clemson, SC	1,565,000
College of Lake County, Highland Park, IL	89,000
Colorado School of Mines, Golden, CO	966,000
Colorado State University, Fort Collins, CO	2,770,000
Columbia University, New York, NY	10,387,000
Community College of Allegheny, Pittsburgh, PA	57,000
Consortium Universities Washington, Washington, DC	70,000
Coordinating Research Council, Atlanta, GA	170,000
Cornell University, Ithaca, NY	9,476,000
Dartmouth College, Hanover, NH	2,006,000
Draper Charles Stark Lab, Cambridge, MA	237,515,000
Drexel University, Philadelphia, PA	1,646,000

(Continued on next page)

DOD's Nonprofits...

(From preceding page)

Duke University, Durham, NC	2,232,000
E E G Systems Laboratory Inc, San Francisco, CA	147,000
East Carolina University, Greenville, NC	245,000
Eastern VA Medical Authority, Norfolk, VA	94,000
Eastern Washington University, Cheney, WA	43,000
Educational Testing Service, Princeton, NJ	345,000
Albert Einstein Medical Center, Philadelphia, PA	221,000
Emmanuel College, Boston, MA	1,493,000
Emory University, Atlanta, GA	480,000
Environmental Research Inst., Michigan, Ann Arbor, MI	10,394,000
Eye Research Inst. Retina Foundation, Boston, MA	215,000
Florida Agric. & Mach. University, Tallahassee, FL	75,000
Florida Atlantic University, Boca Raton, FL	99,000
Florida International University, Miami, FL	129,000
Florida State University, Tallahassee, FL	1,722,000
Fox Chase Cancer Center, Philadelphia, PA	100,000
The Franklin Institute, Philadelphia, PA	501,000
Fred Hutchinson Cancer Center, Seattle, WA	275,000
General Hospital Corp, Boston, MA	8,169,000
George Mason University, Fairfax, VA	184,000
George Washington University, Washington, DC	789,000
Georgetown University, Washington, DC	1,624,000
Georgia Institute Technology, Atlanta, GA	34,096,000
Georgia State University, Atlanta, GA	43,000
Gorgas Memorial Institute, Washington, DC	30,000
Hahnemann University, Philadelphia, PA	160,000
Hampton University, Hampton, VA	59,000
Harbor Branch Foundation Inc, Fort Pierce, FL	181,000
Harvard University, Cambridge, MA	8,044,000
Haskins Laboratories Inc, New Haven, CT	96,000
Health Research Association, Albany, NY	143,000
The Helicon Foundation, San Diego, CA	171,000
Howard University, Washington, DC	421,000
Hudson Institute Inc, Croton-on-Hudson, NY	23,333,000
Human Resources Res. Orgn, Alexandria, VA	3,461,000
Hunter College of New York, New York, NY	44,000
IIT Research Institute, Chicago, IL	55,584,000
Indiana State University, Terre Haute, IN	50,000
Institute Applied Physiol/Med, Seattle, WA	61,000
Institute for Advanced Study, Princeton, NJ	75,000
Institute for Defense Analyses, Alexandria, VA	57,438,000
Institute for Medical Research, San Jose, CA	85,000
Inst. Foreign Policy Analysis, Cambridge, MA	150,000
Institute of Gas Technology, Chicago, IL	301,000
Iowa State Univ. of Science/Tech, Ames, IA	410,000
Jackson State University, Jackson, MS	65,000
Jersey City State College, Jersey City, NJ	105,000
Johns Hopkins University, Baltimore, MD	316,831
Kansas State University, Manhattan, KS	591,000
Kent State University, Kent, OH	129,000
Kestrel Institute, Palo Alto, CA	1,583,000
La Jolla Institute, San Diego, CA	299,000
Lawrence Livermore Laboratory, Berkeley, CA	6,026,000
Lehigh University, Bethlehem, PA	2,178,000
Lincoln University, Lincoln University, PA	119,000
Logistics Management Institute, Bethesda, MD	13,136,000
Loma Linda University, Loma Linda, CA	70,000
Louisiana State University, New Orleans, LA	2,678,000
Louisiana Tech. University, Ruston, LA	68,000
Lowell Observatory, Flagstaff, AZ	36,000
Loyola University of Chicago, Maywood, IL	44,000
Maharishi International University, Fairfield, IA	40,000
Massachusetts Inst. of Technology, Cambridge, MA	363,925,000
Mayo Foundation, Rochester, MN	3,028,000
Medical College of Georgia, Augusta, GA	701,000
Medical College of Pennsylvania, Philadelphia, PA	347,000
Medical College of Wisconsin, Milwaukee, WI	53,000

TO BE CONTINUED...Next Week

Pay Us Sooner, Say Contractors

Contractors who do business with the federal government, particularly small business companies, should be paid more promptly, the Computer and Business Equipment Manufacturers Association (CBEMA) has told members of the U.S. Senate.

In a letter sent to Senators late last month, CBEMA, which represents high technology companies in computers, business equipment and telecommunications, said it is supporting the Prompt Payment Act Amendments of 1987 (S 328). The legislation is currently moving toward consideration by the full Senate. The Washington-based trade group contends that there are loopholes in the current law, which allows the government to pay late, thereby inhibiting both large and small companies from selling to government. In the House of Representatives, a companion bill (H.R.1663) is under consideration by the Government Operations Committee.

"While the Senate legislation frequently is viewed by many as principally a matter of interest to small business government contractors" who may have cash flow problems when they put up large sums to complete a government contract, "timely payment...is a matter of vital importance to all who deal with the government," CBEMA said in its letter to lawmakers.

The government saves a lot of money when it doesn't pay its bills on time. Deputy Secretary of Defense William Taft says that by delaying payments on contracts by 10 days, the government will reduce outlays by $2.8 billion this year.

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How Utility CEOs View Superconductivity...

(Continued from page 7)

still an imperfect science, even with superconductivity, it would appear that storage on a grand scale is still a scientific dream."

How long will it take for advances in superconductivity to have an effect on utility operations?

Ten to 15 years, says Consumers Power chairman McCormick. Five to 10 years, says BPA's Jura, explaining that initial effects will be in the use of superconductors in computers that aid in power systems control.

"Any substantial impact on our industry is at least ten years away," responds James J. O'Conner, chairman and president of Commonwealth Edison. "Perhaps 20 years" before superconductors have an effect on TVA's system, predicts Dean.

"For direct impact, energy storage would be the most likely candidate and even it will take at least ten years to have a measurable effect," says PG&E's Rueger, who adds that PG&E sees no short-term applications for the utility industry.

It will be ten years before superconductivity will impact Southern Company Services operations, says company president Dahlberg.

For the Texas-based utility "the practical advances of superconductivity are beyond the ten-year horizon," says the respondent, who adds that utilities "cannot proceed solely on the basis of what might happen."

Nuclear power took nearly 40 years to reach practical application, notes Detroit Edison's McCarthy. "I have little reason to believe differently for economic superconductive networks."

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