

Burnell. In the early stages of operation, however, the routine for analyzing the recordings had not been fully worked out. The "bit of scruff" looked different both from the scintillating sources and the interference signals she had been told to plot. Though she cannot remember definitely, she "suspects" that she did not record it on the graph. Asked about this point, Hewish says he does not remember if Burnell plotted the pulsar signals on the graph and would trust her memory of what happened; he does remember, however, that the first time she mentioned the signal she showed him the direct recording from the telescope. Thus it would seem that Burnell's discovery of the repeating nature of the signals was a feat of unaided memory and observation, not the result of following a preset routine; in turning up the pulsars she was going beyond the precise letter of her instructions, even if acting within their general framework.

It may indeed be true that the next graduate student down the line would have made the discovery if she hadn't. Yet with

this "what-if" argument, almost every scientist could be stripped of his credit, in that every discovery would have been made by somebody else sooner or later. The historical fact is that it was Burnell, and not another individual, who discovered the pulsar signals.

A prize committee which decides that each of two individuals has made an essential contribution to a discovery may then attempt the exercise of determining whose is the more important. Or, it may think further discrimination is futile and award its prize to both. In the case of pulsars, the Nobel committee took the first course, the Franklin Institute of Philadelphia the second. The institute, which prides itself on the thoroughness of its prize-giving investigations—the process usually takes 1½ to 2 years—awarded its Albert A. Michelson medal to Hewish and Burnell jointly in 1973. The institute declines to discuss the basis of the award, but a prize committee official said that when an institute prize is shared, "We are probably recognizing the recipients for equal efforts."

Questions of credit are sometimes so hard and so invidious to resolve that it seems fairer to blame the prize rather than the prize-giver for any inequity of distribution. "It's precisely questions of this kind that make one skeptical about the whole business of the Nobel prize," says George B. Field, professor of astronomy at Harvard. Field, whose attitude to scientific Brownie points is as detached as anyone's—he declined to be elected to the National Academy of Sciences—believes that science is really a social activity, not the endeavor of lone acting heroes which the institution of Nobel prizes presupposes. Be this as it may, the history of the discovery of pulsars admits of almost all the logically possible arguments on the award of the Nobel prize—that Hewish alone should have received it, that Hewish and Burnell should have received it together, that neither should have won it, and that Nobel prize money, founded at a time when science needed this kind of encouragement, should be put to less invidious and more truly useful purposes.—NICHOLAS WADE

## Energy: A Strategic Oil Reserve as a Hedge Against Embargoes

Disagreement over energy policy between the White House and Congress, and between majority and minority factions within Congress, has been a hallmark of the 1975 legislative year. Yet, amid all the disagreement over oil pricing policies and other energy issues, there has been one important proposition that has enjoyed strong support in Congress as well as in the Executive Branch.

It is that, whatever else is done, the nation should hedge against the possibility of another Arab embargo by establishing a sizable strategic oil reserve, with artificial caverns in Gulf Coast salt domes to be used as the principal repositories; and, further, that the long-neglected naval petroleum reserves should be fully developed as a source of oil for the strategic reserve and for the civilian economy. Now there looks to be a better than even chance that effective action will be taken on this twofold proposition before the year is out.

In his State of the Union message last January, President Ford asked for emergency legislation for strategic storage of 1 billion barrels of oil for civilian needs and

300 million barrels for defense purposes. Such a reserve, coupled with emergency conservation measures, would be expected to compensate for as long as 1 year for an embargo occurring in 1980 or thereafter. The President also asked for quick legislative action to open up the Elk Hills naval petroleum reserve in California. If fully developed, Elk Hills might itself be able to produce enough oil for the strategic reserve.

Although Congress has not yet delivered on the President's requests, it has begun to act. On 8 July, the Senate passed, by 91 to 0, a bill to establish a system of strategic reserves that would include a 3-month supply of crude oil, together with emergency supplies of petroleum products for industry and for any region (such as New England) particularly dependent on imported oil. While this system would not measure up to what President Ford has proposed, the White House would no doubt regard it as representing a significant step in the right direction.

On the same day that the Senate acted, the House of Representatives voted over-

whelmingly to allow the naval petroleum reserves to be transferred from the Navy Department to the Department of the Interior. These include Petroleum Reserve No. 4 in Alaska, on the North Slope, as well as Elk Hills (the Teapot Dome reserve in Wyoming and the Buena Vista Hills reserve in California would be part of the transfer, but these are not significant resources).

"Pet 4," as the Alaskan reserve is called, is almost completely undeveloped. Its proved reserves total no more than 100 million barrels. But, with its estimated reserves ranging from 10 billion to 33 billion barrels, Pet 4's ultimate potential may equal and perhaps far surpass that of the adjoining Prudhoe Bay field, which is expected to be producing up to 2 million barrels a day in the 1980's. Although President Ford asked for authority to explore *and develop* this reserve, the House bill would merely authorize an expanded program of exploration.

Although a thousand productive wells have been drilled at Elk Hills since the reserve was created in 1909, the field is now essentially shut-in. The House bill would open up the reserve and have it developed further, with production rising over a 3-year period to a maximum efficient rate of about 300,000 barrels a day. As reported from committee, the bill would have limited the Elk Hills contribution to the strategic reserve to about one-fourth of the production there. But this limitation was eliminated on the House floor. Otherwise,

the government might have been put in the position of having to buy a large part of the 1.3-billion-barrel reserve at a world price of \$13 a barrel or higher, thus adding to inflationary pressures.

Now, before Congress can complete what it has begun, the Senate must pass a naval-petroleum-reserve measure comparable to the one adopted by the House, and the House must adopt a strategic reserve bill similar to the one passed by the Senate. The omnibus energy bill recently reported to the House floor by the House Commerce Committee would provide for a strategic reserve. But for the reserve provision to become law, it may have to be decoupled from the bill's other, more controversial provisions, such as the one to restrain increases in domestic oil prices. In the Senate, the Armed Services Committee is, at this writing, about to report out a bill that would open Elk Hills to limited production.

The legislation to open up the naval petroleum reserves raises several touchy issues. One is the question whether the reserves as such are indeed a useless anachronism, traceable to a time when the Navy was converting from coal to oil. It is true that as long as the oil remains in the ground, the Navy cannot count on using it in an emergency. Elk Hills oil cannot be pumped fast enough to serve in that kind of situation, and Pet 4 oil cannot now be pumped at all. Moreover, as proponents of opening up the reserves point out, the Defense Production Act of 1950 and the Emergency Petroleum Allocation Act of 1973 give the military services first priority to available oil supplies.

But, persuasive as the foregoing arguments may be, the Navy and its patrons in Congress can argue that the reserves are a hedge of sorts against future uncertainties, even though the oil would not be immediately available in quantity. Those taking this view believe that any pumping of oil from the reserves for either strategic storage or immediate civilian use should be only a temporary stopgap. Also, convinced that jurisdiction over the reserves should remain with the Navy, they resist the idea of placing the reserves under the Department of the Interior. A practical and not unreasonable argument here is that a change in management could interfere with ongoing activities, as at Pet 4 where some 3500 miles of new seismic exploration will have been completed by the end of this year.

Another issue raised by the legislation in regard to the naval reserves has to do with the need to protect Pet 4 as a prime environmental as well as petroleum resource. An onrush of oil development could easily despoil this still largely pristine wilderness.

On the resource and jurisdictional issues, the Armed Services Committees in both the House and the Senate have taken a protective attitude toward the naval reserves. In a showdown on the floor, the House committee sought to keep jurisdiction with the Navy and to limit pumping at Elk Hills to 3 years. But the committee, which has declined in prestige and authority over the past decade because of weak and erratic leadership, came out on the short end of a 305 to 102 vote. On the other hand, the Senate Armed Services Committee, which remains one of the most potent bodies in the Congress, is likely to get its way when it brings its naval petroleum reserve bill to the floor. As now drafted and approved by a subcommittee, this measure also would protect the Navy's jurisdiction and would limit pumping to 5 years.

And significantly, this bill—consistent with the one passed by the House but unlike the measures favored by the President and the House Armed Services Committee—would call for only continued exploration in Pet 4. Environmental groups recognize the need for such exploration, but they want a congressional commitment to development of Pet 4 to be deferred.

According to congressional testimony by James S. Cross of the American Petroleum Institute, oil could be shipped by pipeline from California to salt dome storage along the Gulf for about \$1 per barrel. The domes are immense pillars of virtually pure salt, typically several miles deep and a half mile wide. They number in the hundreds and are found both onshore and offshore. The cost of leaching out large caverns and otherwise preparing the salt domes as oil repositories would come to something less than a dollar a barrel, Cross said.

As the result of salt mining carried on in the past by the leaching method, there are existing cavities capable of accommodating up to 100 million barrels. To create the additional storage necessary to accommodate the 1.3-billion-barrel strategic reserve that the President has called for would take about 9 years, Cross said. But presumably the construction could be speeded if given high priority.

Salt dome storage of petroleum is several times cheaper than surface storage in tanks. Moreover, there is no question of feasibility, because this means of storage is already being employed in the United States and abroad. The principal environmental impact, aside from the incidental spills associated with storage of any kind, has to do with the disposal of the brine leached from the domes in creating the storage cavities. Disposal can be either by reinjection of the brine into underground

strata or by dispersal out to sea via a special pipe laid for the purpose.

Although it is not yet a foregone conclusion that Congress will finally adopt the legislation necessary to open up the naval reserves and create a strategic storage reserve, there seems to be no reason why it should not. As most members of Congress now agree, such a reserve offers perhaps the best short-term hedge against a possibly chaotic disruption of oil supplies. The existence of a strategic reserve could also offer the advantage of reducing pressures to exploit those domestic energy resources that can only be developed at high environmental risk.—LUTHER J. CARTER

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## APPOINTMENTS

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**Alan J. Chapman**, professor of mechanical and aerospace engineering, Rice University, to first dean, new School of Engineering at the university. . . . **Bruce C. Murray**, professor of planetary science, California Institute of Technology, to director, Jet Propulsion Laboratory at the institute. . . . **Thomas F. Jones**, former president, University of South Carolina, to vice president for research, Massachusetts Institute of Technology. . . . **John R. Davis**, head, agricultural engineering, Oregon State University, to director, Agricultural Experiment Station at the university. . . . **Robert S. Stone**, former director, National Institutes of Health, to dean, School of Medicine, University of Oregon Health Sciences Center. . . . **Paul R. McHugh**, chairman, psychiatry department, University of Oregon Medical School, to director, psychiatry and behavioral sciences department, Johns Hopkins University School of Medicine. . . . **Robert W. Leader**, head, pathobiology department, University of Connecticut, to chairman, pathology department, Michigan State University. . . . **Stanley N. Davis**, professor of hydrology, Indiana University, to head, hydrology and water resources department, University of Arizona. . . . **William B. Schwartz**, chairman, medicine department, Tufts University School of Medicine, to university professor for all schools at the university. . . . **Struther Arnott**, professor of biological sciences, Purdue University, to head, biological sciences department at the university. . . . **Michael Zubkoff**, associate chairman, family and community health department, Meharry Medical College, to chairman, community medicine department, Dartmouth Medical School. . . . **Robert S. Daniels**, interim dean, College of Medicine, University of Cincinnati, to dean of the college.